NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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TABLES FOR DETERMINING REDUCTION OF ENERGY AND INTENSITY OF X-RAYS AND GAMMA-RAYS AT VARIOUS SCATTERING ANGLES IN SMALL THICKNESSES OF MATTER

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SUMMARY

Tables are presented for determining the total-absorption coefficients, as well as the intensities and spectral distribution of gamma-rays at any given scattering angle. Only thin scatterers are treated and secondary effects are neglected.

Included are both experimental and computed data on gamma-rays of quantum energies up to 20 million electron volts for all elements for which significant data are available. Published, experimentally verified data on total-absorption coefficients have been used wherever possible. In those energy regions for which such data are still lacking, values of photoelectric, Compton, and pair-formation coefficients were computed using the formulas of Hall and Klein-Nishina and interpolating from the Bethe-Heitler formula, respectively. Examples are included to illustrate the use of the tables.

INTRODUCTION

A determination of the absorption characteristics of gamma-rays in thick absorbers is complicated by secondary factors, such as multiple scattering and angular distribution of annihilation radiation. As a first approximation to the problem of gamma-ray scattering in thick absorbers, a consideration of single scattering in thin absorbers is warranted. The problem of scattering by thin absorbers is much simpler than the corresponding one for thick absorbers because the aforementioned secondary effects may be neglected without serious loss of accuracy.

The following problem is considered herein:

Assume a thin sheet of material of known chemical composition. A beam of gamma-radiation of small cross section is directed normally

upon this sheet. At a given scattering angle (the angle between the primary beam of rays and the scattered beam):

(1) What is the intensity (energy/(unit area)(sec)) of the scattered beam?

(2) What is the degradation (or reduction) of energy in the spectral distribution?

Tables compiled at the NACA Lewis laboratory are presented that provide a convenient and rapid method of solution to this aforementioned problem. These tables include:

(a) Available experimental data on total-absorption coefficients from the literature

(b) Tables of photoelectric absorption coefficients and Compton scattering coefficients computed from the formulas of Hall (reference 1) and Klein-Nishina (reference 2), respectively, as well as a table of pair-formation coefficients, which consist of interpolation of a few values computed by Heitler (reference 3) using the Bethe-Heitler formula (reference 4)

The computed values supplement the experimental ones and are included only for those cases in which the theory has been checked by published experimental data. The tables contain values of absorption coefficients for gamma-rays extending from the soft X-ray region of 0.01 Mev (million electron volts) to the hard gamma-ray region of 20.0 Mev. Auxiliary tables are included for all chemical elements that are solids or liquids at room temperature and for which published data on densities are available.

The tables are preceded by a brief discussion of the theory of the various gamma-ray absorption phenomena and the use of the tables is described with the aid of illustrative examples.

SYMBOLS

The following symbols are used in this report. The values of the numerical constants are calculated from those suggested in reference 5.

A atomic weight, grams per gram-atom

c velocity of electromagnetic radiation in vacuum, 2.99776×10^{10} centimeters per second

E	energy, Mev
E_o	energy of incident gamma-rays, Mev
e	charge of electron, 4.8025×10^{-10} electrostatic units
h	Planck's constant, 6.624×10^{-27} erg seconds
I_o	intensity of incident gamma radiation, energy per unit area per second
I_θ	intensity of gamma radiation scattered at an angle θ, energy per unit area per second
$K, L_1, L_2 \ldots$	electron shells in X-ray terminology
m	rest mass of electron, 9.1066×10^{-28} grams
mc^2	energy equivalent of electron, 0.51083 Mev
N	Avogadro's number, 6.0228×10^{23} per gram-mole
N_a	number of atoms per cubic centimeter, $N\rho/A$
N_e	number of electrons per cubic centimeter, $N\rho Z/A$
r	distance of point of intensity measurement from scattering source
r_o	e^2/mc^2, 2.81×10^{-13} centimeters
Z	atomic number
α	$\dfrac{h\nu}{mc^2} = \dfrac{E_o}{mc^2} = 1.9576\ E_o$
θ	angle between primary beam of gamma-rays and scattered beam
λ	wavelength of gamma radiation, angstroms

μ total-absorption coefficient, centimeter^{-1}

ν frequency of gamma radiation, second^{-1}

ρ density, grams per cubic centimeter

σ Compton scattering coefficient, centimeter^{-1}

τ photoelectric absorption coefficient, centimeter^{-1}

χ pair-formation coefficient, centimeter^{-1}

Subscripts:

a atom

av average

e electron

eff effective

GAMMA-RAY ABSORPTION PHENOMENA AND TABLES

Total-Absorption Coefficient μ

The interaction of hard X-rays or gamma-rays with matter is a function of the energy of the quantum, the atomic number Z of the irradiated material, the density of the material ρ, and various universal constants such as h (Planck's constant), e (electronic charge), and r_o (classical "radius" of an electron).

If a beam of gamma-rays of intensity I_o interacts with a material of small thickness, the intensity of the beam in the same direction after traversing a distance x will be given by

$$I = I_o e^{-\mu x} \tag{1}$$

where μ is the total-absorption coefficient and has the dimensions of reciprocal length. The total-absorption coefficient μ can be expressed as the sum of three distinct effects:

$$\mu = \tau + \sigma + \chi$$

where τ is the photoelectric absorption coefficient, σ is the Compton scattering coefficient, and χ is the pair-formation coefficient.

This relation has been experimentally verified for all elements investigated and for energies up to 17 Mev. Theoretical considerations indicate that the relation remains valid at the upper limit of the tables presented herein, for example, 20.0 Mev (reference 6).

Experimental values of total-mass absorption coefficient μ/ρ (where ρ is density, g/cu cm) from reference 7 will be found in table I. In the energy region for which these values have been measured (0.01 to 2.65 Mev), μ/ρ is monotonic decreasing with increasing energy of incident gamma-rays E_0 for all elements except in the region of an absorption edge. Near an absorption edge, μ/ρ is very difficult to determine and results based on calculations in such energy regions are reliable only to within an order of magnitude. Fortunately, for higher energies, no absorption edges exist (the highest listed in table I is the 0.126-Mev edge for uranium) so that this limitation of the method is not serious.

A fairly large gap exists in available experimental values of μ/ρ between 1.24 and 2.65 Mev for all the elements. Most of these values are computable from the other tables, however, as will be susequently shown. The effect of multiple scattering is negligible when thin sheets (about 1 mm) of irradiated material are considered; all other effects combined (such as chemical combination with other elements (reference 8) and interaction of gamma-rays with atomic nuclei (reference 6)) negligibly affect the value of μ for an individual element. Only the aforementioned three principal effects will therefore be discussed.

Both the cases of heterogeneous spectra of gamma-rays and of homogeneous materials of more than one element present no new difficulties. The total-absorption coefficient μ for a given element in a homogeneous material can be obtained by determining μ for each energy in the spectrum and multiplying by its respective intensity relative to the total beam intensity so that an average value of μ results. Thus

$$\mu_{av} = \frac{\sum_i (E_i) I(E_i)}{\sum_i I(E_i)}$$

where

$\mu(E_i)$ absorption coefficient of gamma-rays of energy E_i

$I(E_i)$ intensity of gamma-rays

The total-absorption coefficient for a continuous known spectrum of gamma radiation may be found by an integration process. Thus 1203

$$\mu_{av} = \frac{\int_{E_{min}}^{E_{max}} \mu(E)I(E)\ dE}{\int_{E_{min}}^{E_{max}} I(E)\ dE}$$

where

E_{min} lowest energy in spectrum

E_{max} highest energy in spectrum

Because $\mu(E)$ and $I(E)$ cannot always be expressed in closed form, the integration is usually performed numerically.

Similarly, μ may be averaged over all the elements in the material by adding the values of μ for each element, which have been multiplied by the relative abundance of the element in the material.

Thus

$$\left(\frac{\mu}{\rho}\right)_{av} = \frac{\sum_i w_i\left(\frac{\mu}{\rho}\right)_i}{\sum_i w_i}$$

where w_i is weight of i^{th} substance.

Consideration of a monochromatic beam of radiation interacting with an element will therefore be sufficient for all practical purposes.

The discussion will be divided into three parts: Compton effect, photoelectric effect, and pair formation.

Compton Effect

Of the three absorption phenomena, the Compton effect is the only one for which closed formulas have been developed that agree closely with experiment for all energies and scattering angles for which they have been checked. Briefly, this effect may be classically explained by assuming that the gamma-ray acts as a particle

or quantum and by attributing to the gamma-ray an energy $h\nu$ and a momentum $h\nu/c$ where h is Planck's constant, ν is the frequency of the incident gamma-ray, and c is the velocity of light in vacuum.

If this concept is assumed, the following expression for the energy of the gamma-ray after being scattered to an angle θ may be readily obtained (reference 9):

$$E_\theta = \frac{E_o}{1 + 1.9576E_o(1-\cos\theta)} \tag{3}$$

where E_o is the incident energy of the gamma-ray and all energies are expressed in Mev. The degradation of energy of the incident gamma-ray in the photoelectric effect and pair formation is meaningless because in these cases the reacting gamma-ray vanishes, leaving instead a photoelectron and a pair of oppositely charged electrons, respectively. The incident gamma-ray retains its identity only in the Compton interaction.

Table II, which was computed from equation (3), presents the degradation of energy E_θ/E_O for values of E_o ranging from 0.01 to 20.0 Mev and for values of θ ranging from 2° to 180°. The values were computed using five significant figures throughout and the final values were then rounded to four decimal places.

The energy of a gamma-ray of initial energy E_o after a single Compton scattering through an angle θ is expressed by equation (3). The corresponding problem of calculating the intensity of a beam of gamma-rays scattered through θ was solved by Klein and Nishina (reference 2) who derived the following formula for the intensity of a beam of gamma-rays of initial energy $h\nu$ scattered by a single free electron at an angle θ:

$$I_\theta = I_o \frac{e^4}{2m^2c^4r^2} \frac{1 + \cos^2\theta}{(1 + \alpha \text{ vers } \theta)^3}\left[1 + \frac{\alpha^2 \text{ vers}^2 \theta}{(1 + \cos^2\theta)(1 + \alpha \text{ vers } \theta)}\right] \tag{4}$$

where

I_o initial beam intensity

α $h\nu/mc^2$

r distance of point of intensity measurement from scattering source

Table III, which was calculated from equation (4), presents I_θ/I_0 as a function of both θ and E_0. The computations were made using five significant figures throughout; the final results were rounded to four decimal places. The results are accurate to within ±3 in the fourth significant figure.

A graph of I_θ/I_0 plotted against θ for several values of α is presented in figure 1.

Klein and Nishina integrated equation (4) over all angles, multiplied by the number of electrons in a unit volume, and obtained (reference 2) the Compton scattering coefficient

$$\sigma = \frac{2\pi N_e e^4}{m^2 c^4}\left\{\frac{1 + \alpha}{\alpha^2}\left[\frac{2(1 + \alpha)}{1 + 2\alpha} - \frac{1}{\alpha}\log_e (1 + 2\alpha)\right] + \frac{1}{2\alpha}\log_e (1 + 2\alpha) - \frac{1 + 3\alpha}{(1 + 2\alpha)^2}\right\} \tag{5}$$

Equation (5) is a function of E_0 through the factor α and of the atomic number Z through the number of electrons N_e. Table IV presents $\sigma(\alpha)$ as a function of E_0 where

$$\sigma(\alpha) = \frac{1 + \alpha}{\alpha^2}\left[\frac{2(1 + \alpha)}{1 + 2\alpha} - \frac{1}{\alpha}\log_e (1 + 2\alpha)\right] + \frac{1}{2\alpha}\log_e (1 + 2\alpha) - \frac{1 + 3\alpha}{(1 + 2\alpha)^2}$$

Table V presents $\frac{2\pi N_e e^4}{m^2 c^4}$ as a function of Z. In order to obtain σ for a given Z and E_0, the value of $\sigma(\alpha)$ corresponding to the desired E_0 is simply multiplied by the value of $\frac{2\pi N_e e^4}{m^2 c^4}$ corresponding to the desired Z.

The values given in table IV have been computed carrying five significant figures throughout the computations and then rounding

the results to four decimal places. The results are accurate to within ±3 in the fourth significant figure.

The values given in table V were computed carrying five significant figures for all the theoretical constants and as many figures for the density as could be found in the handbooks. The final results were rounded to four significant figures but the results are accurate only to the number of significant figures of the density. This same computational procedure was followed for tables VII and IX, the auxiliary tables for the photoelectric absorption coefficient τ and the pair-formation coefficient χ, respectively.

For high energy E or large values of α, equation (5) may be simplified (reference 10) because, if $\alpha >> 1$

$$\sigma \approx \frac{2\pi N_e e^4}{m^2 c^4}\left\{\frac{1}{\alpha}\left[1 - \frac{1}{\alpha}\log_e (2\alpha)\right] + \frac{1}{2\alpha}\log_e (2\alpha) - \frac{3}{4\alpha}\right\}$$

$$\approx \frac{2\pi N_e e^4}{m^2 c^4}\frac{1}{2\alpha}\left(2\alpha + \frac{1}{2}\right)$$

when powers of $1/\alpha$ greater than the first are neglected.

Therefore

$$\sigma \approx \frac{\pi N_e e^4}{m^2 c^4}\frac{1}{\alpha}\left[\log_e (2\alpha) + \frac{1}{2}\right] \tag{6}$$

When α is equal to 3 (1.5 Mev gamma-rays), equation (6) differs by 13 percent from the more exact equation (5); whereas for 5 Mev gamma-rays $(\alpha = 10)$ only a 7-percent difference occurs.

The significance of σ should be clarified. It consists of two separate components. The part of the scattering coefficient that gives a measure of the loss in intensity due to the scattering of radiation out of the direct beam is represented by σ_s, and σ_a comprises that part of the scattering coefficient that gives a measure of the original energy that is transformed into the kinetic energy of the electron and so suffers "true" absorption. Both these effects are contained in σ, which is equal to $\sigma_s + \sigma_a$. These results have been verified by a number of investigators (references 11 to 14).

Photoelectric Effect

In order to consider the absorption due to the photoelectric effect, it is convenient to consider the gamma-ray as a wave packet that interacts with an atom, giving up all energy to an inner electron. The inner electron called a photoelectron escapes from its atom, thus leaving an ion behind. A formula for photoelectric absorption per K-shell valid for all atomic numbers Z when $\frac{h\nu}{mc^2} \gg 1$ has been derived by Hall (reference 1). This result, which is still widely used, may be written

$$\tau_K = \frac{2\sigma_o}{a^{2a^2}e^{a(\pi-2a)}} \tag{7}$$

where

$$\sigma_o = 2\pi\, a_o^2\, \alpha_o^8\, Z^5\, R$$

$$a = \frac{Z}{137} \qquad a_o = \frac{h^2}{4\pi^2 m\, e^2} \qquad \alpha_o = \frac{2\pi e^2}{hc}$$

and

$$R = \frac{k_o^2}{\alpha^5}\left\{\frac{4k_o}{3} + \frac{\epsilon - 2}{\epsilon + 1}\left[k_o\epsilon - \log_e(\epsilon + k_o)\right]\right\}$$

where

$$k_o = (\epsilon^2 - 1)^{1/2}$$

and

$$\epsilon = \alpha + \left(1 - a^2\right)^{1/2}$$

This equation may be written in the more convenient form

$$\tau_K = \frac{2.825\times10^{-33}\, Z^5}{a^{2a^2}e^{a\,(\pi-2a)}}\, R \tag{8}$$

A formula valid for all atomic numbers Z and all $h\nu$ has been developed by Hulme and coworkers but this result is too complex
1203 to present herein. When $h\nu > 2$, moreover, Hulme's formula differs but little from Hall's formula (equation (8)).

The following table taken from reference 15 shows that the values of τ_K calculated by the two different formulas do not differ too much even for values of $\alpha < 4$. (Values in parentheses were calculated from the formula of Hall (reference 1)).

$\alpha = \frac{h\nu}{mc^2}$	τ_K for Al (Z = 13)	τ_K for Sn (Z = 50)	τ_K for Po (Z = 84)
0.452	2.3×10^{-26} (2.45)	4.6×10^{-25} (4.87)	4.61×10^{-24} (4.36)
1.443	3.9×10^{-25} (4.19)	7.1×10^{-24} (7.67)	6.02×10^{-23} (5.23)

Equation (8) is for τ per K-shell, which is twice τ per K-electron. Although the photoelectric absorption in the K-shell is much greater than in any other shell for gamma-rays, the absorption in the L_1-shell cannot be neglected in calculating τ_a (τ per atom). The value of τ_{L_1} for $h\nu > mc^2$ is calculated (reference 16) using a method that parallels the development in reference 1. The resulting formula for τ_{L_1}/τ_K yields numerical results that vary from 1/8 to 1/5 depending on Z. A rough approximation (reference 16) indicates that the absorption in the L_2, L_3, M . . . shells is inappreciable. Thus τ_a becomes equal to $\tau_K + \tau_{L_1}$. The photoelectric absorption coefficient per atom τ_a is 13 to 20 percent higher than τ_K as given in reference 15, depending on the atomic number of the absorber. Multiplying τ_a by the number of atoms per unit volume results in τ in centimeters^{-1}.

Because the formulas of Hall and of Hulme yield closely agreeing values of τ_K when $E_o > 2$, tables of Hall's formula (equation (8)) have been computed for values of E_o from 2 to 10. (The photoelectric absorption coefficient τ is less than 1 percent of the total-absorption coefficient μ when $E_o = 10$ even for the heaviest elements.) Table VI presents τ_K computed from equation (8) as a function of E_o and Z. Seven significant figures were used in the computations and the results were rounded to four.

The auxiliary table for τ (table VII) presents Z for values of fN_a where f is a factor that determines the effect of τ_{L_1} on τ_a for the particular atomic number Z in question. Thus 1203

$$f = 1.13 + \frac{0.07}{81} (Z-1)$$

and a value of τ_K in table VI multiplied by a value in table VII yields τ in centimeters^{-1}.

Pair Formation

Pair formation or the "materialization effect" results from an interaction of gamma-rays of energy $h\nu > 1.022$ Mev with the fields of charged particles (for example, atomic nuclei) resulting in the transformation of the gamma-ray into an electron and a positron. Because the rest mass of an electron is equivalent to an energy of 0.511 Mev, pair formation cannot occur for gamma-rays having an energy less than twice this value. (The rest mass of a positron equals the rest mass of an electron.) The difference between the initial quantum energy $h\nu$ and the rest mass of the two particles produced appears as the kinetic energy of the particles.

Also, pair formation can occur only in the presence of matter. For example, assume a gamma-ray has an energy of exactly $h\nu = 1.022$ Mev. Because both created particles would have zero velocities, the momentum of the gamma-ray $h\nu/c$ will be destroyed. Thus the necessity for the presence of matter to which this momentum may be transferred becomes obvious.

By the use of the Born approximation, Bethe and Heitler (reference 4) developed a method for calculating the probability of pair formation over a wide range of energies. The results could not be expressed in closed form, however, except for very limited energy ranges. The formula derived for the probability of pair formation expressed as cross section is

$$\begin{aligned} \chi_a &= \frac{r_o^2}{137} Z^2 \chi(\alpha) \\ &= 5.797\times10^{-28} Z^2 \chi(\alpha) \end{aligned} \tag{9}$$

where $\chi(\alpha)$ is the function tabulated in table VIII.

In the present problem, the Born approximation assumes equal energy distributions for electron and positron. Obviously, this assumption is not quite valid because the presence of the nuclear Coulomb field will assure an average kinetic energy for the positron that is greater than that of the electron. In addition, this energy difference clearly decreases with increasing $h\nu$. In order to remove this inadequacy in the Bethe-Heitler theory, the exact wave functions for an electron in the presence of a heavy nucleus were used by Jaeger and Hulme in reference 17 and formulas derived for χ, which were estimated as in error by not more than 10 percent. The actual Jaeger-Hulme formulas cannot be expressed in closed form and the calculations are extremely lengthy.

Results obtained using the formulas of Jaeger and Hulme are somewhat higher than corresponding Bethe-Heitler values. Agreement with the Jaeger-Hulme formulas is reported in reference 18.

Despite this inadequacy in the theory of the Bethe-Heitler derivation, however, other investigators report agreement of equation (9) with experimental results (references 19 and 20). This agreement with experiment, although fortuitous, makes reasonable the use of equation (9) to obtain values of χ_a. The values of $\chi(\alpha)$ in table VIII were computed by fitting two functions to several computed values presented in tabular form by Heitler (reference 3, p. 200). The functions that appeared to fit these values were:

(1) From $E_o = 1.50$ to 5.00 Mev:

$$\chi(\alpha) = -0.0001467014(\alpha-2)^6 + 0.0026822917(\alpha-2)^5 - 0.0160373263(\alpha-2)^4 + 0.0265364591(\alpha-2)^3 + 0.0719652774(\alpha-2)^2$$

(2) From $E_o = 3.00$ to 20.00 Mev:

$$\chi(\alpha) = \log_e \left[0.0046043579(\alpha-2)^3 + 0.036474985(\alpha-2)^2 + 0.1583651(\alpha-2) + 1\right]$$

An overlapping occurs between 3.00 and 5.00 Mev but the two functions agree closely in this region.

A graph of $\chi(\alpha)$ from reference 3 (p. 201) is shown in figure 2.

The auxiliary table for χ (table IX) presents $\frac{r_o^2 Z^2 N_a}{137}$ for values of Z. As in the tables for σ and τ, the product of each value in table VIII and a value in table IX results in a value of χ in centimeters^{-1}.

Although the gamma-rays formed by positron annihilation are anisotropically distributed, this so-called excess scattering is small compared with Compton scattering in the energy range of 2 to 5 Mev. At higher energies, the positron will escape from the absorber before annihilation if the absorber is 0.1 centimeter or less thick, which is the limit of the thickness considered herein. In the worst case, 5 Mev gamma-rays in lead, the mean free path of the positron is 0.12 centimeter (reference 3, p. 224) and σ is about the same as χ. This angular effect of pair formation has been neglected herein.

1203

General Problem and Examples

The preceding discussions of the three effects may now be utilized to provide a method for solving the original problem, that is, to obtain the relative intensity and the energy of a beam of gamma-rays at a given scattering angle. For this purpose, a general problem and several solved examples are presented in the following paragraphs.

General problem. - Assume that a beam of gamma-rays of energy E_0 strikes a sheet of element of atomic number Z, which is 1 millimeter thick. What will be the energy and the intensity at unit distance (1 cm) from the center of the sheet of the beam scattered at an angle θ?

Solution. - The energy of the scattered beam E_θ may be found quite simply by using table II. The method of obtaining the intensity, however, is more indirect, as is shown in the following paragraphs.

A formula, equation (4), for obtaining the intensity of gamma radiation scattered to an angle θ is tabulated in table III as I_θ/I_0. The I_0 in this equation, however, is really an effective initial intensity, which must consider photoelectric and pair-formation losses from the original beam. These two effects remove gamma photons from the beam and thus prevent part of the beam from being exposed to scattering electrons.

The effective initial intensity of the gamma-ray beam may be found by averaging the loss in intensity of the beam due to τ and χ in traversing an absorber of thickness x_0. Thus

$$\left(I_o\right)_{eff} = \frac{\int_0^{x_o} I_o\, e^{-(\tau + \chi)x}\, dx}{\int_0^{x_o} dx} = \frac{I_o}{(\tau + \chi)\, x_o}\left[1 - e^{-(\tau + \chi)x_o}\right]$$

or for $(\tau + \chi)x_o$ small,

$$\left(I_o\right)_{eff} = I_o\left[1 - \frac{(\tau + \chi)x_o}{2}\right]$$

This effective initial intensity may now be used with table III to find the intensity at various scattering angles. As is shown in the preceding discussion of the absorption phenomena, τ may be found from tables VI and VII and χ is tabulated in tables VIII and IX. In the energy regions in which τ is significant but not tabulated, $\tau + \chi$ may be found by using tables I, IV, and V. Table I gives μ/ρ and tables IV and V may be used to obtain σ. Therefore, $\tau + \chi$ may be found by subtracting the σ obtained by utilizing tables IV and V from the μ determined by multiplying a value of μ/ρ from table I by the density of the element ρ.

The intensity at any angle θ may then be computed by following the subsequent steps:

(1) The effective initial intensity is found by the method described in the preceding paragraphs.

(2) The number of electrons in the volume of absorber traversed by the gamma-ray beam is calculated. This factor is equal to $\frac{NZ\rho}{A} V$ where V is the volume and is equal to the product of the cross-sectional area of the beam and the thickness of the absorber.

(3) The appropriate I_θ/I_0 is obtained from table III. The intensity of the beam at the given angle is then given by the product of the final values obtained in steps (1) to (3) and the constant $\frac{e^4}{m^2c^4} = 7.896 \times 10^{-26}$ square centimeter per electron.

Incidentally, $\mu = \sigma + \tau + \chi$ so that a rapid and convenient method is provided herein for finding the total-absorption coefficient for X- and gamma-rays in the energy region of 0.01 to 20.0 Mev.

Recently published experimental results (reference 21) in the region from 10.0 to 20.0 Mev agree quite well with such computations, the disagreement with experimental results varying from less than 1 percent to a maximum of 10 percent.

Because of the assumptions made herein, the intensity is a discontinuous function of θ. For a thin absorber, the intensity in the forward direction is usually greater than 95 percent of the incident beam. The angular intensity, however, is obtained by using equation (4), which was derived for a beam of photons of known momentum or zero cross section. In such an ideal case, equation (4) shows that the intensity of a beam making any nonzero angle with the forward direction is very small. In practice, the finite width of the beam causes the intensity to attenuate less rapidly. Table III, however, may be used directly for calculating the relative intensity of gamma-rays scattered at different angles.

EXAMPLES

1. Assume that a beam of 0.500 Mev gamma-rays of 1-square-millimeter cross section strikes a sheet of aluminum 1 millimeter thick. What is the energy and the intensity of the fraction of the beam scattered at 60° at a distance of 1 centimeter from the center of the sheet.

Solution. - Table II lists the value 0.6714 for E_{60}/E_0 when E_0 is 0.500 Mev. The energy of the quanta in the 60° beam is therefore

$$0.6714 \times 0.500 = 0.336 \text{ Mev}$$

The intensity of the 60° beam is found in the following manner: Table I lists the value of 0.079 square centimeter per gram for μ/ρ of aluminum at E_0 of 0.516 Mev, which is found to be 0.081 square centimeter per gram on interpolating to 0.500 Mev. Multiplication of this value by the density of aluminum, 2.699 grams per cubic centimeter, yields the value 0.219 centimeter^{-1} for μ.

A value of 0.5795 square centimeter per electron for $\sigma(\alpha)$ is given in table IV.

The auxiliary table for σ (table V) gives a value of 0.3915 electron per cubic centimeter for aluminum (Z=13) so that σ is 0.227 centimeter^{-1}. This value is greater than μ by 0.008

centimeter^{-1} but, because the experimental value for μ/ρ was given to only two significant figures, the result obviously signifies that the Compton effect accounts for all the absorption. Thus, $(I_o)_{eff} = I_o$.

The number of electrons in the volume traversed by the beam is equal to

$$(6.02 \times 10^{23})\left(2.699 \frac{13 \text{ electrons}}{\text{atoms of Al}}\right)\left(\frac{1}{26.97} \times 10^{-3}\right)$$

$$= 7.826 \times 10^{20} \text{ electrons}$$

From table III for 0.500 Mev gamma-rays, $I_{60} = 0.2135$ so that $I_{60} = (7.826 \times 10^{20})\ (7.896 \times 10^{-26})\ (0.2135I_o) = 1.32 \times 10^{-5}I_o$.

The final solution therefore states that at 60°, 0.336 Mev gamma-rays emerge at 1.32×10^{-5} of the intensity of the original beam.

2. Assume that lead is the absorber in problem 1.

Solution. - The values of E_θ/E_0, $\sigma(\alpha)$, and I_θ/I_0 are independent of atomic number. Therefore, $E_{60} = 0.336$ Mev.

The following paragraph shows that $(I_o)_{eff} \neq I_o$ for this problem.

A value for μ of 2.67 centimeter^{-1} is obtained from table I in the manner suggested in problem 1. Similarly, σ is found to be 0.782 centimeter^{-1} so that

$$\tau = 2.67 - 0.782 = 1.888 \text{ centimeter}^{-1}$$

Then

$$(I_o)_{eff} = \frac{(1 - 1.888 \times 0.1)}{2} I_o = 0.906I_o$$

of if the exponential form is used,

$$(I_o)_{eff} = 0.912I_o$$

The number of electrons in the volume traversed by the beam is now equal to 2.71×10^{21}. Therefore

$$I_{60} = (2.71 \times 10^{21})(7.896 \times 10^{-26})(0.2135)(0.906I_o) = 4.13 \times 10^{-5}I_o.$$

Thus, if lead is the absorber, 0.336 Mev gamma-rays will emerge with an intensity of $4.13 \times 10^{-5} I_o$.

3. Assume that in problem 1 the incident beam consists of equal intensities of 2.00 and 5.00 Mev gamma-rays.

Solution. - The use of table II shows that the beam emerging at 60° will contain gamma-rays of energies $0.3381 \times 2.00 = 0.676$ Mev and $0.1697 \times 5.00 = 0.849$ Mev.

In the process of solving problem 1, τ was found to be negligible; therefore it will be negligible for both energies now considered because τ decreases with increasing energy of the incident gamma-ray. Both energy components of the beam are greater than 1.022 Mev, however, and therefore some pair formation will occur. A value of 0.296 square centimeter per atom is listed in table VIII for $f(\alpha)$ at 2.00 Mev and 1.89 square centimeter per atom for $f(\alpha)$ at 5.00 Mev. From table IX, is obtained the value 0.005912 atom per centimeter so that $\chi = 0.00175$ centimeter^{-1} for the 2.00-Mev ray and 0.0112 centimeter^{-1} for the 5.00-Mev ray.

Originally, I_o for each component was equal to one-half the total incident intensity. The $\left(I_o\right)_{eff}$ for each component therefore becomes:

(a) For the 2.00-Mev ray,

$$\frac{1}{2} I_o \left(1 - \frac{0.000175}{2}\right) = \frac{1}{2} I_o \quad \text{to 3 significant figures}$$

(b) Similarly, for the 5.00-Mev ray

$$\frac{1}{2} I_o \left(1 - \frac{0.00112}{2}\right) = \frac{1}{2} I_o \quad \text{to 3 significant figures}$$

From table III, may be found the values of 0.0492 and 0.0130 for I_{60}/I_o at 2.00 and 5.00 Mev, respectively. The solution to the problem may then be stated that at 60° two components emerge:

(1) A component of 0.676 Mev with an intensity of $1.52 \times 10^{-6} I_o$ and

(2) A component of 0.849 Mev with an intensity of $4.01 \times 10^{-7} I_o$

4. Assume that in problem 3 the scatterer is antimony pentasulfide, Sb_2S_5.

Solution. - The emergent energies of the gamma-rays are independent of the chemical composition of the absorber so that the same two components of 0.676 Mev and 0.849 Mev will emerge.

Before the intensities can be calculated, a knowledge of the
1203 relative weight fractions of antimony and sulfur in Sb_2S_5 is needed, as indicated by the formula for average total-mass absorption coefficient,

$$\left(\frac{\mu}{\rho}\right)_{av} = \frac{\sum_i w_i\left(\frac{\mu}{\rho}\right)_i}{\sum_i w_i}$$

These weight fractions are:

Antimony:

$$\frac{2 \times 121.76}{2 \times 121.76 + 5 \times 32.06} = 0.604$$

Sulfur:

$$1.000 - 0.604 = 0.396$$

The intensities for each of the components will be calculated separately. The intensity of the incident 2.00-Mev beam is calculated as follows:

Tables VI and VII show that τ_S is negligible, but that

$$\tau_{Sb} = 0.0210 \times 0.3881 = 0.0081 \text{ centimeter}^{-1}$$

Tables VIII and IX show that

$$\chi_S = 0.296 \times 0.005772 = 0.0017 \text{ centimeter}^{-1}$$

and

$$\chi_{Sb} = 0.296 \times 0.0499 = 0.0148 \text{ centimeter}^{-1}$$

Therefore

$$\left(\frac{\tau}{\rho}\right)_{Sb_2S_5} = 0 + 0.604 \times \frac{0.0081}{6.684}$$

and

$$\tau_{Sb_2S_5} = 4.12 \times \frac{0.604 \times 0.0081}{6.684} = 0.003 \text{ centimeter}^{-1}$$

Similarly, 1203

$$\left(\frac{\chi}{\rho}\right)_{Sb_2S_5} = \frac{0.396 \times 0.0017}{1.96} + \frac{0.604 \times 0.0148}{6.684}$$

$$= 0.00167$$

and

$$\chi_{Sb_2S_5} = 4.12 \times 0.00167$$

$$= 0.0069 \text{ centimeter}^{-1}$$

so that

$$(\tau + \chi)_{Sb_2S_5} = 0.0099 \text{ centimeter}^{-1}$$

To three significant figures, $\left(I_o\right)_{eff}$ is still $I_o/2$ according to the preceding results.

The number of electrons in the volume traversed by the beam is equal to

$$(6.02 \times 10^{23}) \frac{(4.12)\ (2 \times 51 + 5 \times 16)}{(2 \times 121.76 + 5 \times 32.06)} \text{ electrons} \times 10^{-3}$$
$$= 1.12 \times 10^{21} \text{ electrons}$$

The emergent intensity of the 2.00-Mev incident beam is therefore

$$(1.12 \times 10^{21})\ (7.896 \times 10^{-26})\ \left(0.0492\ \frac{I_o}{2}\right) = 4.34 \times 10^{-6}\ \frac{I_o}{2}$$

The intensity of the 5.00-Mev beam is similarly found:

Thus, τ_S is negligible; τ_{Sb} is 0.0025 centimeter^{-1}; and $\tau_{Sb_2S_5}$ is 0.0009 centimeter^{-1}.

The values of 0.0109 and 0.0945 centimeter^{-1} for χ_S and χ_{Sb}, respectively, are obtained from tables VII and IX so that a value for $\chi_{Sb_2S_5}$ is readily obtained as 0.0442 centimeter^{-1}. Therefore $(\tau + \chi)_{Sb_2S_5} = 0.0451$ centimeter^{-1} and $\left(I_o\right)_{eff} = 0.998\,\frac{I_o}{2}$.

The emergent intensity of the 5.00-Mev component is then

$$\left(1.12 \times 10^{21}\right) \left(7.896 \times 10^{-26}\right) (0.0130) \left(0.998 \frac{I_o}{2}\right) = 5.75 \times 10^{-7} I_o$$

The solution to the problem is thus:

(1) A 0.676-Mev component emerges with an intensity of $2.17 \times 10^{-6} I_o$

and

(2) A 0.849-Mev component emerges with an intensity of $5.75 \times 10^{-7} I_o$

CONCLUDING REMARKS

Tables are presented for determining the intensity and spectral distribution of gamma-rays at any scattering angle. The total-absorption coefficient may also be found by use of the tables. The accuracy of the results obtained through use of the tables varies from an uncertainty of 15 percent to one of a fraction of 1 percent with the greater inaccuracy in direct proportion to the effect of pair formation on the total-absorption coefficient.

Lewis Flight Propulsion Laboratory,
National Advisory Committee for Aeronautics,
Cleveland, Ohio, May 24, 1949.

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TABLE I - TOTAL MASS ABSORPTION COEFFICIENT μ/ρ, SQUARE CENTIMETER PER GRAM (REFERENCE 7)

[Dashes indicate values have not been measured]

λ (A)	E_0 (Mev)	Atomic Number															
		1	3	4	5	6	7	8	10	11	12	13	16	17	18	20	26
		Element															
		H	Li	Be	B	C	N	O	Ne	Na	Mg	Al	S	Cl	A	Ca	Fe
1.235	0.0100	0.460	0.67	0.95	1.35	2.42	3.95	5.7	12.4	17.1	21.4	26.3	49.5	55.5	62.5	90	181
.631	.0196	.435	.225	.255	.305	.467	.610	.900	1.80	2.30	3.0	3.73	6.90	8.40	9.80	13.3	27.0
.417	.0297	.390	.180	.185	.198	.256	.310	.372	.580	.750	.940	1.170	2.10	2.47	2.95	3.97	8.45
.331	.0374	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
.260	.0477	.385	.156	.166	.175	.185	.200	.210	.270	.305	.343	.402	.650	.750	.850	1.10	2.28
.200	.0620	.375	.151	.160	.165	.175	.180	.183	.210	.225	.250	.270	.400	.445	.500	.630	1.10
.175	.0708	.360	.144	.150	.155	.163	.166	.169	.185	.195	.205	.228	.335	.341	.400	.460	.800
.146	.0849	.340	------	------	------	.155	------	.162	------	.170	.176	.195	.249	.280	------	.345	.520
.142	.0873	.330	------	------	------	.153	------	------	------	------	------	.191	------	------	------	------	.515
.130	.0953	.320	.132	------	.149	.152	------	.157	------	.160	.168	.186	.220	.230	------	.290	.424
.120	.103	------	------	------	------	.150	------	.154	------	------	.163	.172	.200	------	------	------	.368
.113	.110	.310	------	------	------	.147	------	.153	------	.155	.160	.166	.189	.195	------	.230	.337
.098	.126	.280	.125	------	.138	.142	------	.144	------	.150	.152	.158	.166	.176	------	.200	.265
.080	.155	.255	------	------	------	.137	------	------	------	------	------	.146	------	.164	------	------	.235
.072	.172	.250	.118	------	.132	.136	------	.137	------	.139	.140	.143	.150	.158	------	.180	.202
.064	.194	.245	.110	------	.126	.130	------	.130	------	.130	.130	.130	.139	.142	------	.155	.178
.050	.248	------	------	------	------	------	.120	------	------	------	------	.115	------	------	------	------	.140
.040	.310	.205	------	------	------	.110	------	------	------	------	------	.105	------	------	------	------	.118
.030	.413	.180	------	------	------	.095	------	------	------	------	------	.093	------	------	------	------	.095
.024	.518	.165	------	------	------	.080	------	------	------	------	------	.079	------	------	------	------	.080
.010	1.24	.117	------	------	------	.059	------	------	------	------	------	.058	------	------	------	------	.058
.0047	2.65	.078	------	------	------	.0385	------	------	------	------	------	.0380	------	------	------	------	------

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TABLE I - TOTAL MASS ABSORPTION COEFFICIENT μ/ρ, SQUARE CENTIMETER PER GRAM (REFERENCE 7) - Concluded

[Dashes indicate values have not been measured]

λ (A)	E_0 (Mev)	Atomic Number															
		28	29	30	35	38	42	47	50	53	56	73	74	78	79	82	92
		Element															
		Ni	Cu	Zn	Br	Sr	Mo	Ag	Sn	I	Ba	Ta	W	Pt	Au	Pb	U
1.235	0.0100	208	230	250	----	----	----	125	140	----	----	----	95	115	122	137	----
.631	.0196	34	36.2	41.0	56.8	72.5	15.0	19.6	23.0	26.4	31.1	72	75	84.5	87	98	----
.417	.0297	10.5	11.45	12.3	19.0	24.0	30.0	41	45	9.2	10.5	21.5	22.5	27.4	28.4	32	----
.331	.0374	----	----	----	----	----	----	21.7	24.5	----	5.4	----	----	----	----	18.1	----
.260	.0477	2.89	3.16	3.58	5.3	6.50	8.20	11.4	12.8	14.2	16.1	6.7	6.85	8.0	8.3	10.0	----
.200	.0620	1.45	1.55	1.78	2.4	3.32	4.30	5.48	6.20	7.0	8.0	3.4	3.50	4.25	4.40	4.90	5.40
.175	.0708	1.05	1.12	1.26	1.9	2.24	2.95	3.96	4.50	5.1	5.7	10.0	10.5	2.97	3.13	3.48	3.95
.146	.0849	----	.680	----	----	----	----	2.48	2.66	----	----	6.75	----	7.60	7.85	2.35	2.70
.142	.0873	.630	.670	.780	----	----	1.55	2.31	2.64	----	----	----	6.75	7.20	7.33	2.10	----
.130	.0953	----	.551	----	----	----	----	1.97	2.12	----	----	5.10	----	6.30	6.40	6.55	2.20
.120	.103	.430	.455	.537	----	----	----	1.61	1.77	----	2.2	----	4.60	4.92	4.98	5.20	1.90
.113	.110	----	.422	----	----	----	----	1.47	1.60	----	----	3.80	----	4.40	4.50	4.75	----
.098	.126	----	----	----	----	----	----	----	----	----	----	2.80	----	3.15	3.21	3.50	3.90
.080	.155	.264	.268	.308	----	----	----	----	----	----	----	----	2.30	2.40	2.42	2.50	2.70
.072	.172	----	.232	----	----	----	----	----	----	----	----	1.75	----	2.00	2.05	2.10	2.25
.064	.194	----	.198	----	----	----	.413	----	----	----	----	1.35	----	1.52	1.55	1.64	1.80
.050	.248	----	.155	----	----	----	----	----	----	----	----	----	----	.86	.88	1.00	----
.040	.310	----	.126	----	----	----	----	----	----	----	----	----	----	----	----	.62	----
.030	.413	----	.100	----	----	----	----	----	----	----	----	----	----	----	----	.38	----
.024	.516	----	.081	----	----	----	----	----	----	----	----	----	----	----	----	.21	----
.010	1.24	----	.057	----	----	----	----	----	----	----	----	----	----	----	----	.071	.082
.0047	2.65	----	.038	----	----	----	----	----	----	----	----	----	----	----	----	.0425	.044

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TABLE II - RATIO OF ENERGIES OF COMPTON SCATTERED

E_o (Mev)	θ, (deg) 2	4	6	8	10	15	20	30	40	50	60
0.01	1.0000	1.0000	0.9999	0.9998	0.9997	0.9993	0.9989	0.9974	0.9954	0.9930	0.9903
.02	1.0000	.9999	.9998	.9996	.9994	.9987	.9976	.9948	.9909	.9862	.9808
.03	1.0000	.9999	.9997	.9994	.9991	.9980	.9965	.9922	.9865	.9794	.9714
.04	1.0000	.9998	.9996	.9992	.9988	.9973	.9953	.9896	.9820	.9728	.9623
.05	.9999	.9998	.9995	.9990	.9985	.9967	.9941	.9871	.9776	.9662	.9534
.06	.9999	.9997	.9994	.9989	.9982	.9960	.9930	.9845	.9732	.9597	.9446
.07	.9999	.9997	.9992	.9987	.9979	.9953	.9918	.9819	.9689	.9534	.9359
.08	.9999	.9996	.9991	.9985	.9976	.9947	.9907	.9794	.9647	.9471	.9274
.09	.9999	.9996	.9990	.9983	.9973	.9940	.9895	.9769	.9604	.9408	.9190
.10	.9999	.9995	.9989	.9981	.9970	.9933	.9883	.9745	.9562	.9347	.9108
.15	.9998	.9993	.9984	.9971	.9955	.9901	.9826	.9622	.9357	.9051	.8720
.20	.9998	.9990	.9979	.9962	.9941	.9869	.9769	.9501	.9161	.8773	.8363
.25	.9997	.9988	.9973	.9952	.9927	.9836	.9713	.9384	.8973	.8512	.8034
.30	.9996	.9986	.9968	.9943	.9912	.9804	.9658	.9270	.8792	.8266	.7730
.35	.9996	.9983	.9962	.9933	.9897	.9772	.9603	.9159	.8618	.9034	.7448
.40	.9995	.9981	.9957	.9925	.9882	.9740	.9549	.9051	.8452	.7814	.7186
.45	.9995	.9979	.9952	.9915	.9868	.9709	.9496	.8944	.8291	.7606	.6942
.50	.9994	.9976	.9946	.9906	.9853	.9677	.9443	.8841	.8137	.7410	.6714
.55	.9993	.9974	.9941	.9896	.9839	.9646	.9391	.8740	.7988	.7222	.6501
.60	.9993	.9971	.9936	.9887	.9825	.9615	.9339	.8640	.7844	.7044	.6300
.65	.9992	.9969	.9930	.9878	.9811	.9584	.9288	.8543	.7706	.6875	.6112
.70	.9992	.9967	.9926	.9869	.9796	.9554	.9237	.8449	.7572	.6714	.5934
.75	.9991	.9964	.9921	.9859	.9782	.9524	.9187	.8356	.7443	.6560	.5767
.80	.9990	.9962	.9915	.9850	.9768	.9493	.9137	.8266	.7319	.6413	.5609
.85	.9990	.9959	.9910	.9841	.9753	.9463	.9088	.8177	.7198	.6272	.5459
.90	.9989	.9957	.9904	.9832	.9739	.9434	.9039	.8091	.7081	.6137	.5317
.95	.9989	.9955	.9899	.9822	.9725	.9404	.8991	.8005	.6968	.6008	.5182
1.00	.9988	.9952	.9894	.9813	.9712	.9375	.8944	.7922	.6859	.5885	.5054
1.2	.9986	.9943	.9873	.9776	.9655	.9259	.8759	.7606	.6453	.5437	.4599
1.4	.9983	.9933	.9852	.9740	.9601	.9146	.8581	.7314	.6093	.5053	.4219
1.6	.9981	.9925	.9831	.9704	.9546	.9036	.8411	.7044	.5771	.4720	.3897
1.8	.9979	.9915	.9811	.9668	.9492	.8928	.8247	.6793	.5481	.4427	.3621
2.0	.9976	.9906	.9790	.9632	.9438	.8823	.8090	.6560	.5219	.4169	.3381
2.2	.9974	.9896	.9769	.9598	.9386	.8721	.7938	.6341	.4981	.3939	.3171
2.4	.9971	.9887	.9749	.9563	.9334	.8620	.7792	.6137	.4764	.3734	.2986
2.6	.9969	.9878	.9729	.9528	.9282	.8522	.7651	.5946	.4564	.3548	.2821
2.8	.9967	.9868	.9709	.9494	.9231	.8426	.7515	.5766	.4381	.3381	.2673
3.0	.9964	.9859	.9688	.9459	.9181	.8333	.7384	.5597	.4212	.3228	.2540
3.2	.9962	.9849	.9668	.9425	.9131	.8241	.7258	.5437	.4056	.3089	.2420
3.4	.9959	.9841	.9647	.9391	.9082	.8151	.7136	.5286	.3911	.2961	.2311
3.6	.9957	.9831	.9628	.9358	.9033	.8064	.7018	.5144	.3775	.2843	.2211
3.8	.9955	.9822	.9608	.9325	.8985	.7978	.6903	.5009	.3649	.2734	.2119
4.0	.9952	.9813	.9589	.9292	.8937	.7894	.6793	.4880	.3531	.2634	.2034
4.2	.9950	.9804	.9569	.9259	.8890	.7811	.6685	.4758	.3420	.2540	.1957
4.4	.9948	.9794	.9549	.9227	.8843	.7731	.6581	.4643	.3316	.2453	.1884
4.6	.9945	.9786	.9530	.9195	.8797	.7652	.6480	.4532	.3219	.2372	.1817
4.8	.9943	.9776	.9510	.9163	.8750	.7575	.6383	.4427	.3126	.2295	.1755
5.0	.9940	.9768	.9491	.9130	.8705	.7499	.6288	.4327	.3040	.2224	.1697
5.2	.9938	.9758	.9471	.9098	.8661	.7424	.6196	.4230	.2957	.2157	.1642
5.4	.9936	.9749	.9453	.9067	.8616	.7352	.6107	.4139	.2879	.2094	.1591
5.6	.9933	.9740	.9433	.9036	.8573	.7281	.6020	.4051	.2805	.2034	.1543
5.8	.9931	.9730	.9414	.9005	.8529	.7210	.5936	.3966	.2735	.1978	.1498
6.0	.9929	.9722	.9396	.8974	.8486	.7142	.5854	.3886	.2668	.1925	.1455
6.2	.9927	.9712	.9376	.8944	.8443	.7074	.5774	.3808	.2604	.1874	.1415
6.4	.9925	.9704	.9358	.8913	.8401	.7008	.5696	.3733	.2544	.1826	.1377
6.6	.9922	.9695	.9339	.8883	.8359	.6943	.5621	.3662	.2486	.1781	.1340
6.8	.9920	.9686	.9321	.8853	.8318	.6879	.5547	.3593	.2431	.1738	.1306
7.0	.9918	.9677	.9301	.8823	.8277	.6817	.5475	.3526	.2378	.1696	.1274
7.2	.9915	.9668	.9282	.8794	.8237	.6755	.5405	.3462	.2327	.1657	.1243
7.4	.9913	.9659	.9264	.8764	.8196	.6695	.5337	.3400	.2278	.1620	.1213
7.6	.9910	.9651	.9246	.8735	.8157	.6636	.5271	.3341	.2232	.1584	.1185

NACA

1203

GAMMA-RAY E_θ/E_0, COMPUTED FROM EQUATION (3)

θ, (deg)												E_0
70	80	90	100	110	120	130	140	150	160	170	180	(Mev)
0.9873	0.9841	0.9808	0.9775	0.9744	0.9714	0.9688	0.9666	0.9647	0.9634	0.9626	0.9623	0.01
.9748	.9686	.9623	.9560	.9501	.9446	.9396	.9354	.9318	.9295	.9279	.9274	.02
.9628	.9537	.9446	.9355	.9270	.9190	.9120	.9060	.9012	.8977	.8956	.8949	.03
.9510	.9392	.9274	.9158	.9049	.8949	.8861	.8785	.8725	.8681	.8655	.8646	.04
.9395	.9252	.9108	.8969	.8839	.8720	.8615	.8526	.8456	.8404	.8373	.8363	.05
.9282	.9115	.8949	.8788	.8639	.8502	.8382	.8282	.8202	.8145	.8110	.8098	.06
.9173	.8983	.8795	.8615	.8447	.8295	.8163	.8052	.7964	.7900	.7862	.7849	.07
.9066	.8854	.8646	.8447	.8263	.8098	.7954	.7833	.7739	.7670	.7629	.7615	.08
.8961	.8729	.8502	.8286	.8088	.7910	.7756	.7627	.7526	.7453	.7409	.7394	.09
.8859	.8607	.8363	.8131	.7920	.7730	.7567	.7431	.7324	.7248	.7202	.7186	.10
.8381	.8047	.7730	.7437	.7173	.6942	.6746	.6585	.6460	.6371	.6318	.6300	.15
.7952	.7556	.7186	.6852	.6556	.6300	.6086	.5912	.5778	.5684	.5627	.5609	.20
.7564	.7120	.6714	.6352	.6036	.5767	.5543	.5364	.5227	.5130	.5073	.5054	.25
.7213	.6733	.6300	.5920	.5593	.5317	.5090	.4909	.4771	.4675	.4618	.4599	.30
.6893	.6385	.5934	.5543	.5210	.4932	.4705	.4525	.4389	.4294	.4237	.4219	.35
.6600	.6071	.5609	.5211	.4876	.4599	.4374	.4197	.4063	.3970	.3915	.3897	.40
.6331	.5787	.5317	.4917	.4583	.4308	.4086	.3913	.3782	.3692	.3638	.3621	.45
.6083	.5528	.5054	.4654	.4322	.4052	.3834	.3665	.3538	.3450	.3398	.3381	.50
.5853	.5292	.4815	.4418	.4090	.3824	.3612	.3446	.3323	.3238	.3188	.3171	.55
.5641	.5075	.4599	.4204	.3882	.3621	.3413	.3253	.3133	.3050	.3002	.2986	.60
.5443	.4874	.4401	.4011	.3693	.3438	.3236	.3080	.2963	.2883	.2836	.2821	.65
.5259	.4690	.4219	.3834	.3522	.3273	.3076	.2924	.2811	.2734	.2688	.2673	.70
.5086	.4518	.4052	.3672	.3367	.3123	.2931	.2783	.2674	.2599	.2555	.2540	.75
.4925	.4359	.3897	.3524	.3224	.2986	.2799	.2655	.2550	.2477	.2434	.2420	.80
.4773	.4211	.3754	.3386	.3093	.2860	.2678	.2539	.2436	.2365	.2324	.2311	.85
.4631	.4072	.3621	.3260	.2972	.2745	.2568	.2432	.2332	.2264	.2224	.2211	.90
.4497	.3942	.3497	.3142	.2861	.2639	.2466	.2334	.2237	.2170	.2132	.2119	.95
.4370	.3820	.3381	.3033	.2757	.2540	.2372	.2244	.2149	.2085	.2047	.2034	1.0
.3928	.3400	.2986	.2662	.2408	.2211	.2058	.1942	.1858	.1800	.1766	.1755	1.2
.3567	.3063	.2673	.2372	.2138	.1957	.1817	.1712	.1636	.1583	.1553	.1543	1.4
.3267	.2787	.2420	.2139	.1922	.1755	.1627	.1531	.1461	.1413	.1386	.1377	1.6
.3013	.2556	.2211	.1947	.1746	.1591	.1473	.1384	.1320	.1276	.1251	.1243	1.8
.2796	.2361	.2034	.1787	.1599	.1455	.1346	.1264	.1204	.1164	.1140	.1132	2.0
.2608	.2193	.1884	.1652	.1475	.1340	.1238	.1162	.1107	.1069	.1047	.1040	2.2
.2444	.2048	.1755	.1535	.1369	.1243	.1147	.1076	.1024	.0989	.0968	.0962	2.4
.2299	.1921	.1642	.1434	.1277	.1158	.1068	.1001	.0953	.0920	.0901	.0894	2.6
.2171	.1808	.1543	.1345	.1197	.1084	.1000	.0936	.0891	.0860	.0842	.0836	2.8
.2056	.1708	.1455	.1267	.1126	.1019	.0939	.0879	.0836	.0807	.0790	.0785	3.0
.1952	.1619	.1377	.1197	.1063	.0962	.0886	.0829	.0788	.0760	.0744	.0739	3.2
.1859	.1538	.1306	.1135	.1007	.0910	.0838	.0784	.0745	.0719	.0704	.0699	3.4
.1774	.1465	.1243	.1079	.0956	.0864	.0795	.0744	.0707	.0682	.0667	.0662	3.6
.1696	.1399	.1185	.1028	.0910	.0822	.0756	.0707	.0672	.0648	.0634	.0630	3.8
.1625	.1339	.1132	.0981	.0869	.0785	.0721	.0674	.0640	.0618	.0604	.0600	4.0
.1560	.1283	.1084	.0939	.0831	.0750	.0689	.0644	.0612	.0590	.0577	.0573	4.2
.1500	.1232	.1040	.0900	.0796	.0718	.0660	.0617	.0586	.0565	.0553	.0549	4.4
.1444	.1185	.1000	.0864	.0764	.0689	.0633	.0592	.0562	.0542	.0530	.0526	4.6
.1392	.1141	.0962	.0831	.0735	.0662	.0608	.0568	.0570	.0520	.0509	.0505	4.8
.1344	.1100	.0927	.0801	.0707	.0638	.0586	.0547	.0519	.0500	.0490	.0486	5.0
.1299	.1062	.0894	.0772	.0682	.0615	.0564	.0527	.0500	.0482	.0472	.0468	5.2
.1257	.1027	.0864	.0746	.0658	.0593	.0544	.0508	.0482	.0465	.0455	.0452	5.4
.1218	.0994	.0836	.0721	.0636	.0573	.0526	.0491	.0466	.0449	.0439	.0436	5.6
.1181	.0963	.0809	.0698	.0656	.0555	.0509	.0475	.0451	.0434	.0425	.0422	5.8
.1146	.0934	.0785	.0676	.0597	.0537	.0493	.0460	.0436	.0420	.0411	.0408	6.0
.1113	.0907	.0761	.0656	.0578	.0521	.0478	.0446	.0423	.0408	.0399	.0396	6.2
.1082	.0881	.0739	.0637	.0561	.0505	.0463	.0432	.0410	.0395	.0387	.0384	6.4
.1052	.0856	.0718	.0619	.0545	.0491	.0450	.0420	.0398	.0384	.0375	.0373	6.6
.1025	.0833	.0699	.0602	.0530	.0477	.0437	.0408	.0387	.0373	.0365	.0362	6.8
.0998	.0811	.0680	.0585	.0516	.0464	.0425	.0397	.0376	.0363	.0355	.0352	7.0
.0973	.0791	.0662	.0570	.0502	.0452	.0414	.0386	.0366	.0353	.0345	.0343	7.2
.0950	.0771	.0646	.0556	.0489	.0440	.0403	.0376	.0370	.0344	.0336	.0334	7.4
.0927	.0752	.0630	.0542	.0477	.0429	.0393	.0367	.0348	.0335	.0328	.0325	7.6

NACA

TABLE II - RATIO OF ENERGIES OF COMPTON SCATTERED

E_0 (Mev)	θ, (deg)										
	2	4	6	8	10	15	20	30	40	50	60
7.8	0.9908	0.9641	0.9228	0.8706	0.8117	0.6578	0.5206	0.3283	0.2187	0.1549	0.1158
8.0	.9906	.9632	.9210	.8678	.8078	.6521	.5143	.3228	.2144	.1516	.1132
8.2	.9903	.9624	.9192	.8649	.8039	.6464	.5081	.3174	.2103	.1485	.1108
8.4	.9901	.9614	.9173	.8621	.8001	.6409	.5021	.3122	.2063	.1455	.1084
8.6	.9898	.9606	.9156	.8593	.7963	.6354	.4962	.3072	.2025	.1426	.1062
8.8	.9896	.9597	.9137	.8564	.7926	.6301	.4905	.3023	.1988	.1398	.1040
9.0	.9894	.9589	.9120	.8536	.7888	.6249	.4848	.2976	.1952	.1371	.1019
9.2	.9891	.9579	.9102	.8508	.7852	.6197	.4794	.2930	.1918	.1345	.1000
9.4	.9889	.9571	.9084	.8481	.7815	.6146	.4740	.2886	.1885	.1320	.0980
9.6	.9887	.9562	.9067	.8454	.7779	.6096	.4687	.2843	.1853	.1296	.0962
9.8	.9884	.9554	.9049	.8427	.7743	.6047	.4636	.2801	.1822	.1273	.0944
10.0	.9882	.9545	.9032	.8400	.7708	.5999	.4586	.2760	.1792	.1251	.0927
10.2	.9879	.9537	.9014	.8373	.7672	.5951	.4537	.2721	.1763	.1230	.0910
10.4	.9878	.9527	.8997	.8347	.7638	.5904	.4489	.2683	.1735	.1209	.0894
10.6	.9876	.9519	.8979	.8320	.7603	.5858	.4442	.2646	.1708	.1189	.0879
10.8	.9873	.9510	.8962	.8293	.7569	.5813	.4396	.2609	.1682	.1169	.0864
11.0	.9871	.9501	.8945	.8267	.7535	.5768	.4350	.2574	.1656	.1150	.0850
11.2	.9868	.9493	.8928	.8241	.7501	.5724	.4306	.2540	.1631	.1132	.0836
11.4	.9866	.9484	.8910	.8216	.7468	.5681	.4263	.2506	.1607	.1115	.0822
11.6	.9864	.9476	.8894	.8190	.7435	.5638	.4220	.2474	.1584	.1097	.0809
11.8	.9861	.9467	.8877	.8165	.7402	.5596	.4179	.2442	.1561	.1081	.0797
12.0	.9859	.9459	.8860	.8139	.7370	.5554	.4138	.2411	.1539	.1065	.0785
12.2	.9857	.9450	.8843	.8114	.7338	.5513	.4098	.2381	.1518	.1049	.0773
12.4	.9854	.9442	.8826	.8089	.7306	.5473	.4059	.2352	.1497	.1034	.0761
12.6	.9852	.9433	.8810	.8065	.7274	.5433	.4020	.2323	.1477	.1019	.0750
12.8	.9849	.9425	.8793	.8039	.7243	.5394	.3982	.2295	.1457	.1005	.0739
13.0	.9847	.9416	.8777	.8015	.7212	.5356	.3945	.2268	.1438	.0991	.0729
13.2	.9845	.9408	.8760	.7990	.7181	.5318	.3909	.2241	.1419	.0978	.0718
13.4	.9843	.9399	.8744	.7966	.7151	.5280	.3873	.2215	.1401	.0964	.0708
13.6	.9841	.9391	.8728	.7942	.7120	.5243	.3838	.2190	.1383	.0951	.0699
13.8	.9838	.9383	.8711	.7918	.7090	.5207	.3803	.2165	.1366	.0939	.0689
14.0	.9836	.9374	.8695	.7895	.7060	.5171	.3770	.2140	.1349	.0927	.0680
14.2	.9834	.9366	.8678	.7871	.7031	.5136	.3736	.2117	.1333	.0915	.0671
14.4	.9831	.9357	.8663	.7847	.7001	.5101	.3704	.2093	.1317	.0903	.0662
14.6	.9829	.9349	.8646	.7824	.6973	.5066	.3672	.2071	.1301	.0892	.0654
14.8	.9826	.9341	.8630	.7800	.6943	.5032	.3640	.2048	.1286	.0881	.0646
15.0	.9824	.9333	.8614	.7777	.6915	.4998	.3609	.2027	.1271	.0870	.0638
15.2	.9822	.9324	.8598	.7754	.6887	.4965	.3578	.2005	.1256	.0860	.0630
15.4	.9819	.9316	.8583	.7732	.6859	.4933	.3548	.1985	.1242	.0850	.0622
15.6	.9817	.9308	.8567	.7709	.6831	.4901	.3519	.1964	.1228	.0840	.0615
15.8	.9815	.9300	.8551	.7686	.6803	.4869	.3490	.1944	.1214	.0830	.0607
16.0	.9813	.9291	.8535	.7664	.6776	.4837	.3462	.1924	.1201	.0820	.0600
16.2	.9811	.9283	.8520	.7642	.6749	.4806	.3433	.1905	.1188	.0811	.0593
16.4	.9808	.9275	.8504	.7620	.6722	.4776	.3406	.1886	.1175	.0802	.0586
16.6	.9806	.9266	.8489	.7598	.6695	.4745	.3379	.1868	.1162	.0793	.0580
16.8	.9804	.9258	.8473	.7575	.6668	.4716	.3352	.1850	.1150	.0784	.0573
17.0	.9801	.9250	.8458	.7553	.6642	.4686	.3326	.1832	.1138	.0776	.0567
17.2	.9799	.9242	.8442	.7532	.6616	.4657	.3300	.1815	.1126	.0768	.0561
17.4	.9796	.9234	.8427	.7510	.6590	.4628	.3274	.1797	.1115	.0759	.0555
17.6	.9794	.9226	.8413	.7489	.6564	.4600	.3249	.1781	.1104	.0752	.0549
17.8	.9792	.9217	.8397	.7468	.6539	.4572	.3224	.1764	.1093	.0744	.0543
18.0	.9790	.9210	.8382	.7447	.6513	.4544	.3200	.1748	.1082	.0736	.0537
18.2	.9788	.9201	.8367	.7426	.6488	.4517	.3176	.1732	.1071	.0728	.0532
18.4	.9786	.9194	.8352	.7405	.6463	.4490	.3152	.1717	.1061	.0721	.0526
18.6	.9783	.9185	.8337	.7383	.6438	.4463	.3129	.1701	.1051	.0714	.0521
18.8	.9781	.9178	.8322	.7363	.6414	.4437	.3106	.1686	.1041	.0707	.0515
19.0	.9778	.9169	.8307	.7342	.6389	.4410	.3083	.1671	.1031	.0700	.0510
19.2	.9776	.9161	.8293	.7322	.6365	.4385	.3061	.1657	.1021	.0693	.0505
19.4	.9774	.9153	.8278	.7301	.6341	.4359	.3039	.1643	.1012	.0686	.0500
19.6	.9771	.9145	.8263	.7281	.6318	.4334	.3018	.1629	.1002	.0680	.0495
19.8	.9769	.9137	.8249	.7261	.6294	.4309	.2996	.1615	.0993	.0674	.0491
20.0	.9767	.9129	.8234	.7241	.6270	.4284	.2975	.1601	.0984	.0667	.0486

GAMMA-RAY E_θ/E_0, COMPUTED FROM EQUATION (3) - Concluded

θ, (deg)												E_0
70	80	90	100	110	120	130	140	150	160	170	180	(Mev)
0.0905	0.0734	0.0655	0.0528	0.0465	0.0418	0.0383	0.0358	0.0339	0.0327	0.0319	0.0317	7.8
.0885	.0717	.0638	.0516	.0454	.0408	.0374	.0349	.0331	.0319	.0312	.0309	8.0
.0865	.0701	.0586	.0504	.0444	.0399	.0365	.0341	.0323	.0311	.0304	.0302	8.2
.0846	.0686	.0573	.0493	.0434	.0390	.0357	.0333	.0316	.0304	.0297	.0295	8.4
.0828	.0671	.0561	.0482	.0424	.0381	.0349	.0325	.0318	.0297	.0291	.0288	8.6
.0811	.0656	.0549	.0471	.0415	.0373	.0341	.0318	.0311	.0291	.0284	.0282	8.8
.0794	.0643	.0537	.0461	.0406	.0365	.0334	.0311	.0295	.0284	.0278	.0276	9.0
.0778	.0630	.0526	.0452	.0397	.0357	.0327	.0305	.0289	.0278	.0272	.0270	9.2
.0763	.0617	.0515	.0442	.0389	.0350	.0320	.0298	.0283	.0272	.0266	.0264	9.4
.0748	.0605	.0505	.0434	.0381	.0343	.0314	.0292	.0277	.0267	.0261	.0259	9.6
.0734	.0593	.0495	.0425	.0374	.0336	.0308	.0287	.0272	.0262	.0256	.0254	9.8
.0720	.0582	.0486	.0417	.0367	.0329	.0302	.0281	.0266	.0257	.0251	.0249	10.0
.0707	.0571	.0477	.0409	.0360	.0323	.0296	.0276	.0261	.0252	.0246	.0244	10.2
.0695	.0561	.0468	.0402	.0353	.0317	.0290	.0271	.0263	.0247	.0242	.0240	10.4
.0682	.0551	.0460	.0394	.0347	.0311	.0285	.0266	.0258	.0242	.0237	.0235	10.6
.0671	.0541	.0452	.0387	.0340	.0306	.0280	.0261	.0247	.0238	.0233	.0231	10.8
.0659	.0532	.0444	.0381	.0334	.0300	.0275	.0256	.0243	.0234	.0229	.0227	11.0
.0648	.0523	.0436	.0374	.0329	.0295	.0270	.0252	.0239	.0230	.0225	.0228	11.2
.0638	.0514	.0429	.0368	.0323	.0290	.0266	.0248	.0234	.0226	.0221	.0219	11.4
.0627	.0506	.0422	.0362	.0318	.0285	.0261	.0243	.0231	.0222	.0217	.0215	11.6
.0617	.0498	.0415	.0369	.0312	.0280	.0257	.0239	.0227	.0218	.0214	.0212	11.8
.0608	.0490	.0408	.0350	.0307	.0276	.0253	.0235	.0223	.0215	.0210	.0208	12.0
.0598	.0482	.0402	.0344	.0303	.0272	.0248	.0232	.0220	.0211	.0207	.0205	12.2
.0589	.0475	.0396	.0339	.0298	.0267	.0245	.0228	.0216	.0208	.0203	.0202	12.4
.0580	.0468	.0390	.0334	.0293	.0263	.0241	.0224	.0213	.0205	.0200	.0199	12.6
.0572	.0461	.0384	.0329	.0289	.0259	.0237	.0221	.0209	.0202	.0197	.0196	12.8
.0564	.0454	.0378	.0324	.0284	.0255	.0234	.0218	.0206	.0199	.0194	.0193	13.0
.0556	.0447	.0373	.0319	.0280	.0252	.0230	.0214	.0203	.0196	.0191	.0190	13.2
.0548	.0441	.0367	.0315	.0276	.0248	.0227	.0211	.0200	.0193	.0188	.0187	13.4
.0540	.0435	.0362	.0310	.0272	.0244	.0224	.0208	.0197	.0190	.0186	.0184	13.6
.0533	.0429	.0357	.0306	.0268	.0241	.0220	.0205	.0194	.0187	.0183	.0182	13.8
.0525	.0423	.0352	.0302	.0265	.0238	.0217	.0202	.0192	.0185	.0180	.0179	14.0
.0518	.0417	.0347	.0297	.0261	.0234	.0214	.0200	.0189	.0182	.0178	.0177	14.2
.0512	.0412	.0343	.0293	.0258	.0231	.0211	.0197	.0187	.0180	.0176	.0174	14.4
.0505	.0406	.0338	.0290	.0254	.0228	.0208	.0194	.0184	.0177	.0173	.0172	14.6
.0498	.0401	.0334	.0286	.0251	.0225	.0206	.0192	.0182	.0175	.0171	.0170	14.8
.0492	.0396	.0329	.0282	.0248	.0222	.0203	.0189	.0179	.0172	.0169	.0167	15.0
.0486	.0391	.0325	.0278	.0244	.0219	.0200	.0187	.0177	.0170	.0166	.0165	15.2
.0480	.0386	.0321	.0275	.0241	.0216	.0198	.0184	.0175	.0168	.0164	.0163	15.4
.0474	.0381	.0317	.0271	.0238	.0214	.0195	.0182	.0172	.0166	.0162	.0161	15.6
.0468	.0376	.0313	.0268	.0235	.0211	.0193	.0180	.0170	.0164	.0160	.0159	15.8
.0463	.0372	.0309	.0265	.0232	.0208	.0191	.0178	.0168	.0162	.0158	.0157	16.0
.0457	.0368	.0306	.0262	.0230	.0206	.0188	.0175	.0166	.0160	.0156	.0155	16.2
.0452	.0363	.0302	.0258	.0227	.0203	.0186	.0173	.0164	.0158	.0154	.0153	16.4
.0447	.0359	.0298	.0256	.0224	.0201	.0184	.0171	.0162	.0156	.0153	.0152	16.6
.0442	.0355	.0295	.0252	.0222	.0199	.0182	.0169	.0160	.0154	.0151	.0150	16.8
.0437	.0351	.0292	.0250	.0219	.0196	.0180	.0167	.0158	.0153	.0149	.0148	17.0
.0432	.0347	.0288	.0247	.0216	.0194	.0178	.0165	.0157	.0151	.0147	.0146	17.2
.0427	.0343	.0285	.0244	.0214	.0192	.0176	.0164	.0155	.0149	.0146	.0145	17.4
.0422	.0339	.0282	.0241	.0212	.0190	.0174	.0162	.0153	.0147	.0144	.0143	17.6
.0418	.0336	.0279	.0239	.0209	.0188	.0172	.0160	.0152	.0146	.0142	.0142	17.8
.0414	.0332	.0276	.0236	.0207	.0186	.0170	.0158	.0150	.0144	.0141	.0140	18.0
.0409	.0328	.0273	.0234	.0205	.0184	.0168	.0156	.0148	.0143	.0139	.0138	18.2
.0405	.0325	.0270	.0231	.0203	.0182	.0166	.0155	.0147	.0141	.0138	.0137	18.4
.0401	.0322	.0267	.0229	.0200	.0180	.0164	.0153	.0145	.0140	.0136	.0135	18.6
.0397	.0318	.0264	.0226	.0198	.0178	.0163	.0152	.0144	.0138	.0135	.0134	18.8
.0393	.0315	.0262	.0224	.0196	.0176	.0161	.0150	.0142	.0137	.0134	.0133	19.0
.0389	.0312	.0259	.0222	.0194	.0174	.0159	.0148	.0141	.0135	.0132	.0131	19.2
.0385	.0309	.0257	.0219	.0192	.0172	.0158	.0147	.0139	.0134	.0131	.0130	19.4
.0381	.0306	.0254	.0217	.0190	.0171	.0156	.0145	.0138	.0133	.0130	.0129	19.6
.0377	.0303	.0252	.0215	.0189	.0169	.0155	.0144	.0136	.0131	.0128	.0127	19.8
.0374	.0300	.0249	.0213	.0187	.0167	.0153	.0143	.0135	.0130	.0127	.0126	20.0

1203

TABLE III - INTENSITY OF GAMMA-RAYS AT VARIOUS SCATTERING ANGLES

E_o (Mev)	θ, (deg)										
	2	4	6	8	10	15	20	30	40	50	60
0.01	0.9994	0.9974	0.9942	0.9897	0.9840	0.9646	0.9381	0.8680	0.7824	0.6917	0.6067
.02	.9993	.9972	.9939	.9892	.9832	.9626	.9349	.8614	.7721	.6780	.5900
.03	.9993	.9972	.9935	.9886	.9823	.9607	.9315	.8546	.7615	.6639	.5732
.04	.9992	.9970	.9932	.9880	.9814	.9588	.9284	.8482	.7517	.6510	.5579
.05	.9992	.9968	.9929	.9874	.9805	.9569	.9250	.8415	.7415	.6378	.5424
.06	.9992	.9966	.9926	.9869	.9797	.9550	.9219	.8352	.7320	.6257	.5284
.07	.9991	.9966	.9923	.9864	.9788	.9531	.9186	.8287	.7222	.6132	.5141
.08	.9991	.9964	.9920	.9858	.9779	.9512	.9153	.8222	.7126	.6012	.5005
.09	.9991	.9962	.9917	.9853	.9771	.9493	.9122	.8162	.7037	.5900	.4880
.10	.9990	.9962	.9914	.9847	.9762	.9474	.9090	.8099	.6944	.5786	.4754
.15	.9988	.9955	.9898	.9819	.9719	.9381	.8933	.7799	.6517	.5274	.4204
.20	.9987	.9947	.9882	.9790	.9676	.9289	.8780	.7516	.6127	.4827	.3747
.25	.9985	.9940	.9865	.9762	.9633	.9198	.8633	.7250	.5775	.4439	.3367
.30	.9983	.9933	.9850	.9736	.9591	.9109	.8488	.6995	.5449	.4094	.3042
.35	.9981	.9926	.9834	.9708	.9549	.9021	.8346	.6754	.5150	.3789	.2764
.40	.9980	.9919	.9819	.9680	.9507	.8934	.8207	.6524	.4876	.3518	.2524
.45	.9978	.9911	.9803	.9653	.9465	.8848	.8072	.6306	.4622	.3275	.2316
.50	.9976	.9904	.9787	.9626	.9424	.8764	.7940	.6098	.4389	.3058	.2135
.55	.9974	.9897	.9772	.9599	.9382	.8681	.7812	.5901	.4172	.2863	.1975
.60	.9972	.9890	.9756	.9572	.9342	.8599	.7686	.5712	.3972	.2686	.1834
.65	.9971	.9884	.9740	.9545	.9302	.8518	.7565	.5535	.3788	.2528	.1710
.70	.9969	.9876	.9725	.9518	.9261	.8438	.7445	.5364	.3614	.2382	.1598
.75	.9967	.9869	.9710	.9491	.9221	.8359	.7328	.5200	.3453	.2249	.1497
.80	.9965	.9862	.9694	.9465	.9181	.8281	.7213	.5044	.3303	.2128	.1406
.85	.9964	.9855	.9679	.9438	.9142	.8204	.7101	.4895	.3162	.2017	.1324
.90	.9962	.9848	.9664	.9412	.9102	.8128	.6992	.4753	.3031	.1914	.1249
.95	.9960	.9841	.9648	.9386	.9063	.8054	.6885	.4616	.2907	.1820	.1181
1.00	.9958	.9834	.9633	.9360	.9024	.7980	.6781	.4486	.2792	.1733	.1119
1.20	.9951	.9806	.9572	.9256	.8872	.7695	.6386	.4016	.2394	.1444	.0916
1.40	.9944	.9779	.9512	.9154	.8722	.7425	.6024	.3617	.2078	.1224	.0767
1.60	.9937	.9751	.9452	.9054	.8577	.7168	.5692	.3275	.1823	.1053	.0653
1.80	.9930	.9724	.9393	.8956	.8435	.6924	.5386	.2980	.1613	.0918	.0563
2.00	.9923	.9696	.9334	.8858	.8296	.6692	.5104	.2724	.1439	.0808	.0492
2.20	.9916	.9669	.9276	.8763	.8161	.6471	.4843	.2500	.1293	.0717	.0434
2.40	.9909	.9641	.9218	.8669	.8029	.6261	.4603	.2304	.1169	.0642	.0386
2.60	.9902	.9614	.9161	.8576	.7899	.6061	.4379	.2130	.1062	.0578	.0345
2.80	.9895	.9587	.9105	.8485	.7774	.5870	.4171	.1976	.0970	.0524	.0311
3.00	.9888	.9560	.9049	.8395	.7650	.5688	.3978	.1838	.0890	.0477	.0282
3.20	.9880	.9534	.8993	.8307	.7530	.5514	.3798	.1714	.0820	.0436	.0257
3.40	.9873	.9507	.8938	.8220	.7412	.5348	.3630	.1603	.0758	.0401	.0235
3.60	.9866	.9480	.8883	.8134	.7298	.5189	.3473	.1503	.0703	.0369	.0216
3.80	.9859	.9454	.8829	.8050	.7185	.5038	.3326	.1412	.0654	.0342	.0199
4.00	.9852	.9428	.8776	.7966	.7076	.4892	.3188	.1329	.0610	.0317	.0184
4.20	.9845	.9401	.8723	.7885	.6968	.4753	.3058	.1254	.0571	.0295	.0171
4.40	.9838	.9375	.8670	.7804	.6863	.4620	.2937	.1185	.0535	.0276	.0159
4.60	.9831	.9349	.8618	.7725	.6761	.4492	.2822	.1122	.0503	.0258	.0148
4.80	.9825	.9333	.8566	.7646	.6660	.4369	.2715	.1064	.0474	.0242	.0138
5.00	.9818	.9297	.8515	.7569	.6562	.4252	.2613	.1010	.0447	.0227	.0130
5.20	.9811	.9272	.8464	.7493	.6466	.4139	.2517	.0960	.0422	.0214	.0122
5.40	.9804	.9246	.8413	.7418	.6372	.4030	.2427	.0915	.0400	.0202	.0115
5.60	.9797	.9221	.8363	.7344	.6280	.3926	.2341	.0872	.0379	.0191	.0108
5.80	.9790	.9195	.8314	.7272	.6190	.3825	.2260	.0832	.0360	.0181	.0102
6.00	.9783	.9170	.8265	.7200	.6101	.3729	.2183	.0796	.0342	.0171	.0097
6.20	.9776	.9145	.8216	.7129	.6015	.3636	.2110	.0761	.0326	.0162	.0092
6.40	.9769	.9119	.8168	.7059	.5930	.3547	.2040	.0729	.0310	.0154	.0087
6.60	.9762	.9094	.8120	.6991	.5848	.3460	.1975	.0699	.0296	.0147	.0082
6.80	.9755	.9070	.8072	.6923	.5766	.3377	.1912	.0671	.0283	.0140	.0078
7.00	.9748	.9045	.8025	.6856	.5687	.3297	.1852	.0644	.0271	.0134	.0075
7.20	.9741	.9020	.7979	.6791	.5609	.3220	.1795	.0619	.0259	.0128	.0071
7.40	.9734	.8995	.7932	.6726	.5533	.3145	.1741	.0596	.0249	.0122	.0068
7.60	.9727	.8971	.7886	.6662	.5458	.3073	.1689	.0574	.0238	.0117	.0065

1203

AFTER COMPTON SCATTERING I_θ/I_0 ,COMPUTED FROM EQUATION (4)

θ, (deg)												E_o
70	80	90	100	110	120	130	140	150	160	170	180	(Mev)
0.5371	0.4905	0.4714	0.4807	0.5162	0.5724	0.6418	0.7155	0.7845	0.8406	0.8770	0.8897	0.01
.5179	.4688	.4464	.4512	.4804	.5284	.5881	.6515	.7107	.7586	.7898	.8005	.02
.4988	.4475	.4224	.4232	.4467	.4874	.5386	.5930	.6436	.6845	.7109	.7201	.03
.4817	.4287	.4014	.3990	.4180	.4529	.4972	.5444	.5882	.6235	.6463	.6542	.04
.4646	.4102	.3810	.3758	.3908	.4204	.4587	.4994	.5372	.5676	.5872	.5939	.05
.4493	.3937	.3632	.3558	.3675	.3928	.4261	.4617	.4947	.5211	.5381	.5440	.06
.4340	.3775	.3458	.3364	.3452	.3668	.3956	.4265	.4551	.4780	.4928	.4979	.07
.4194	.3624	.3297	.3188	.3250	.3433	.3683	.3952	.4202	.4401	.4529	.4573	.08
.4064	.3489	.3155	.3033	.3076	.3231	.3450	.3686	.3906	.4081	.4193	.4232	.09
.3932	.3355	.3016	.2883	.2908	.3039	.3228	.3435	.3627	.3780	.3878	.3912	.10
.3378	.2806	.2462	.2299	.2265	.2314	.2408	.2516	.2618	.2699	.2751	.2769	.15
.2939	.2390	.2058	.1888	.1827	.1833	.1874	.1929	.1983	.2027	.2055	.2065	.20
.2588	.2071	.1758	.1590	.1515	.1498	.1510	.1535	.1562	.1585	.1600	.1605	.25
.2299	.1815	.1523	.1361	.1281	.1250	.1245	.1252	.1262	.1272	.1279	.1282	.30
.2059	.1608	.1336	.1183	.1101	.1062	.1046	.1042	.1043	.1046	.1048	.1049	.35
.1857	.1437	.1185	.1040	.0960	.0916	.0894	.0883	.0878	.0876	.0875	.0875	.40
.1687	.1296	.1061	.0924	.0846	.0800	.0774	.0759	.0750	.0745	.0742	.0741	.45
.1540	.1176	.0958	.0828	.0752	.0706	.0678	.0660	.0649	.0642	.0638	.0637	.50
.1414	.1073	.0870	.0748	.0674	.0628	.0599	.0580	.0567	.0559	.0555	.0553	.55
.1304	.0985	.0794	.0679	.0608	.0563	.0534	.0514	.0500	.0492	.0487	.0485	.60
.1209	.0909	.0730	.0621	.0553	.0509	.0479	.0459	.0445	.0436	.0431	.0430	.65
.1123	.0842	.0673	.0570	.0504	.0462	.0433	.0412	.0399	.0390	.0385	.0383	.70
.1047	.0782	.0623	.0525	.0463	.0421	.0393	.0373	.0359	.0350	.0345	.0344	.75
.0980	.0729	.0579	.0486	.0426	.0386	.0358	.0339	.0326	.0317	.0312	.0310	.80
.0919	.0682	.0539	.0451	.0394	.0355	.0328	.0309	.0296	.0288	.0283	.0281	.85
.0864	.0639	.0504	.0420	.0365	.0328	.0302	.0284	.0271	.0263	.0258	.0256	.90
.0814	.0601	.0472	.0392	.0339	.0304	.0278	.0261	.0249	.0241	.0236	.0234	.95
.0769	.0566	.0444	.0367	.0316	.0282	.0258	.0241	.0229	.0221	.0217	.0216	1.00
.0623	.0454	.0352	.0288	.0245	.0216	.0195	.0181	.0170	.0164	.0160	.0159	1.20
.0517	.0374	.0287	.0232	.0196	.0171	.0153	.0140	.0132	.0126	.0123	.0122	1.40
.0437	.0314	.0239	.0192	.0160	.0138	.0123	.0113	.0105	.0100	.0098	.0097	1.60
.0374	.0267	.0202	.0161	.0134	.0115	.0102	.0092	.0086	.0082	.0079	.0078	1.80
.0325	.0230	.0174	.0137	.0113	.0097	.0085	.0077	.0071	.0068	.0066	.0065	2.00
.0285	.0201	.0150	.0118	.0097	.0082	.0072	.0065	.0060	.0057	.0055	.0055	2.20
.0252	.0177	.0132	.0103	.0084	.0071	.0062	.0056	.0052	.0049	.0047	.0047	2.40
.0225	.0157	.0116	.0091	.0074	.0062	.0054	.0049	.0045	.0042	.0041	.0040	2.60
.0202	.0140	.0104	.0080	.0065	.0055	.0048	.0043	.0039	.0037	.0036	.0035	2.80
.0182	.0126	.0093	.0072	.0058	.0049	.0042	.0038	.0034	.0032	.0031	.0031	3.00
.0165	.0114	.0084	.0064	.0052	.0043	.0038	.0033	.0031	.0029	.0028	.0028	3.20
.0150	.0104	.0076	.0058	.0047	.0039	.0034	.0030	.0027	.0026	.0025	.0025	3.40
.0138	.0094	.0069	.0053	.0042	.0035	.0030	.0027	.0025	.0023	.0022	.0022	3.60
.0126	.0086	.0063	.0048	.0038	.0032	.0028	.0024	.0022	.0021	.0020	.0020	3.80
.0117	.0080	.0058	.0044	.0035	.0029	.0025	.0022	.0020	.0019	.0018	.0018	4.00
.0108	.0073	.0053	.0040	.0032	.0027	.0023	.0020	.0018	.0017	.0017	.0016	4.20
.0100	.0068	.0049	.0037	.0030	.0025	.0021	.0019	.0017	.0016	.0015	.0015	4.40
.0093	.0063	.0046	.0034	.0027	.0023	.0019	.0017	.0016	.0015	.0014	.0014	4.60
.0037	.0059	.0042	.0032	.0025	.0021	.0018	.0016	.0014	.0014	.0013	.0013	4.80
.0081	.0055	.0039	.0030	.0024	.0020	.0017	.0015	.0013	.0012	.0012	.0012	5.00
.0076	.0051	.0037	.0028	.0022	.0018	.0016	.0014	.0012	.0012	.0011	.0011	5.20
.0072	.0048	.0034	.0026	.0020	.0017	.0014	.0013	.0012	.0011	.0010	.0010	5.40
.0067	.0045	.0032	.0024	.0019	.0016	.0014	.0012	.0011	.0010	.0010	.0010	5.60
.0063	.0042	.0030	.0023	.0018	.0015	.0013	.0011	.0010	.0009	.0009	.0009	5.80
.0060	.0040	.0029	.0022	.0017	.0014	.0012	.0010	.0010	.0009	.0008	.0008	6.00
.0057	.0038	.0027	.0020	.0016	.0013	.0011	.0010	.0009	.0008	.0008	.0008	6.20
.0054	.0036	.0026	.0019	.0015	.0012	.0010	.0009	.0008	.0008	.0008	.0007	6.40
.0051	.0034	.0024	.0018	.0014	.0012	.0010	.0009	.0008	.0007	.0007	.0007	6.60
.0048	.0032	.0023	.0017	.0014	.0011	.0009	.0008	.0008	.0007	.0007	.0007	6.80
.0046	.0031	.0022	.0016	.0013	.0010	.0009	.0008	.0007	.0007	.0006	.0006	7.00
.0044	.0029	.0021	.0015	.0012	.0010	.0008	.0007	.0007	.0006	.0006	.0006	7.20
.0042	.0028	.0020	.0015	.0012	.0009	.0008	.0007	.0006	.0006	.0006	.0006	7.40
.0040	.0026	.0019	.0014	.0011	.0009	.0008	.0007	.0006	.0006	.0005	.0005	7.60

NACA

TABLE III - INTENSITY OF GAMMA-RAYS AT VARIOUS SCATTERING ANGLES AFTER

E_o (Mev)	θ, (deg)										
	2	4	6	8	10	15	20	30	40	50	60
7.80	0.9721	0.8946	0.7841	0.6599	0.5385	0.3004	0.1640	0.0553	0.0229	0.0112	0.0062
8.00	.9714	.8922	.7796	.6537	.5313	.2937	.1593	.0533	.0220	.0107	.0060
8.20	.9707	.8898	.7751	.6475	.5242	.2872	.1547	.0515	.0212	.0103	.0057
8.40	.9700	.8874	.7707	.6415	.5173	.2809	.1504	.0497	.0204	.0099	.0055
8.60	.9693	.8850	.7663	.6355	.5106	.2748	.1463	.0480	.0196	.0095	.0052
8.80	.9686	.8826	.7619	.6296	.5039	.2690	.1423	.0464	.0189	.0092	.0050
9.00	.9680	.8802	.7576	.6238	.4974	.2633	.1385	.0449	.0182	.0088	.0049
9.20	.9673	.8778	.7533	.6181	.4910	.2578	.1348	.0435	.0176	.0085	.0047
9.40	.9666	.8754	.7490	.6124	.4848	.2525	.1313	.0421	.0170	.0082	.0045
9.60	.9659	.8731	.7448	.6069	.4786	.2473	.1280	.0408	.0164	.0079	.0043
9.80	.9652	.8707	.7406	.6014	.4726	.2423	.1247	.0396	.0159	.0076	.0042
10.00	.9646	.8684	.7365	.5959	.4667	.2374	.1216	.0384	.0154	.0074	.0040
10.20	.9639	.8661	.7324	.5906	.4608	.2327	.1186	.0372	.0149	.0071	.0039
10.40	.9632	.8637	.7283	.5853	.4551	.2282	.1158	.0362	.0144	.0069	.0038
10.60	.9625	.8614	.7242	.5801	.4495	.2237	.1130	.0351	.0140	.0067	.0036
10.80	.9618	.8591	.7202	.5749	.4440	.2194	.1103	.0341	.0136	.0065	.0035
11.00	.9612	.8568	.7162	.5699	.4386	.2153	.1077	.0332	.0132	.0063	.0034
11.20	.9605	.8546	.7123	.5649	.4334	.2112	.1052	.0323	.0128	.0061	.0033
11.40	.9598	.8523	.7084	.5599	.4281	.2073	.1028	.0314	.0124	.0059	.0032
11.60	.9591	.8500	.7045	.5550	.4230	.2034	.1005	.0306	.0120	.0057	.0031
11.80	.9585	.8477	.7006	.5502	.4180	.1997	.0983	.0298	.0117	.0055	.0030
12.00	.9578	.8455	.6968	.5454	.4131	.1961	.0961	.0290	.0114	.0054	.0029
12.20	.9571	.8433	.6930	.5408	.4082	.1926	.0940	.0283	.0111	.0052	.0028
12.40	.9564	.8410	.6892	.5361	.4035	.1891	.0920	.0276	.0108	.0051	.0028
12.60	.9558	.8388	.6855	.5315	.3988	.1858	.0901	.0269	.0105	.0049	.0027
12.80	.9551	.8366	.6818	.5270	.3942	.1826	.0882	.0262	.0102	.0048	.0026
13.00	.9544	.8344	.6781	.5225	.3897	.1794	.0863	.0256	.0099	.0047	.0025
13.20	.9538	.8322	.6744	.5181	.3852	.1763	.0846	.0250	.0097	.0046	.0025
13.40	.9531	.8300	.6708	.5138	.3809	.1733	.0828	.0244	.0094	.0044	.0024
13.60	.9524	.8278	.6672	.5095	.3766	.1704	.0812	.0238	.0092	.0043	.0023
13.80	.9518	.8256	.6637	.5052	.3724	.1676	.0796	.0233	.0090	.0042	.0023
14.00	.9511	.8235	.6601	.5010	.3682	.1648	.0780	.0227	.0088	.0041	.0022
14.20	.9504	.8213	.6566	.4969	.3641	.1609	.0765	.0222	.0086	.0040	.0022
14.40	.9498	.8192	.6531	.4928	.3601	.1595	.0750	.0217	.0084	.0039	.0021
14.60	.9491	.8170	.6497	.4888	.3562	.1569	.0736	.0212	.0082	.0038	.0020
14.80	.9484	.8149	.6463	.4848	.3523	.1544	.0722	.0208	.0080	.0037	.0020
15.00	.9478	.8128	.6429	.4808	.3485	.1520	.0708	.0204	.0078	.0036	.0020
15.20	.9471	.8107	.6395	.4769	.3447	.1496	.0695	.0199	.0076	.0035	.0019
15.40	.9465	.8085	.6362	.4731	.3410	.1472	.0683	.0195	.0074	.0035	.0019
15.60	.9458	.8064	.6328	.4693	.3374	.1450	.0670	.0191	.0073	.0034	.0018
15.80	.9451	.8043	.6295	.4655	.3338	.1428	.0658	.0187	.0071	.0033	.0018
16.00	.9445	.8023	.6263	.4618	.3303	.1406	.0647	.0183	.0070	.0032	.0017
16.20	.9438	.8002	.6230	.4581	.3268	.1385	.0635	.0180	.0068	.0032	.0017
16.40	.9432	.7981	.6198	.4545	.3234	.1364	.0624	.0176	.0067	.0031	.0016
16.60	.9425	.7961	.6166	.4509	.3201	.1344	.0613	.0172	.0065	.0030	.0016
16.80	.9419	.7940	.6134	.4474	.3168	.1324	.0603	.0169	.0064	.0030	.0016
17.00	.9412	.7920	.6103	.4439	.3135	.1305	.0593	.0166	.0063	.0029	.0016
17.20	.9406	.7899	.6072	.4404	.3103	.1286	.0583	.0163	.0061	.0028	.0015
17.40	.9399	.7879	.6040	.4370	.3072	.1267	.0573	.0160	.0060	.0028	.0015
17.60	.9392	.7859	.6010	.4336	.3040	.1249	.0564	.0156	.0059	.0027	.0014
17.80	.9386	.7839	.5979	.4303	.3010	.1232	.0554	.0154	.0058	.0027	.0014
18.00	.9379	.7818	.5949	.4270	.2980	.1214	.0545	.0151	.0057	.0026	.0014
18.20	.9373	.7798	.5919	.4237	.2950	.1197	.0536	.0148	.0056	.0026	.0014
18.40	.9366	.7779	.5889	.4205	.2921	.1181	.0528	.0145	.0054	.0025	.0013
18.60	.9360	.7759	.5859	.4173	.2892	.1164	.0520	.0143	.0053	.0025	.0013
18.80	.9353	.7739	.5830	.4141	.2864	.1149	.0511	.0140	.0052	.0024	.0013
19.00	.9347	.7719	.5801	.4110	.2836	.1133	.0503	.0138	.0051	.0024	.0013
19.20	.9340	.7700	.5772	.4079	.2808	.1118	.0496	.0135	.0050	.0023	.0012
19.40	.9334	.7680	.5743	.4049	.2781	.1103	.0488	.0133	.0050	.0023	.0012
19.60	.9327	.7660	.5714	.4019	.2754	.1088	.0481	.0131	.0049	.0022	.0012
19.80	.9321	.7641	.5686	.3989	.2728	.1074	.0473	.0128	.0048	.0022	.0012
20.00	.9314	.7622	.5658	.3959	.2702	.1060	.0466	.0126	.0047	.0022	.0011

COMPTON SCATTERING I_θ/I_0 ,COMPUTED FROM EQUATION (4) - Concluded

θ, (deg)												E_0
70	80	90	100	110	120	130	140	150	160	170	180	(Mev)
0.0038	0.0025	0.0018	0.0013	0.0010	0.0008	0.0007	0.0006	0.0006	0.0005	0.0005	0.0005	7.80
.0036	.0024	.0017	.0013	.0010	.0008	.0007	.0006	.0006	.0005	.0005	.0005	8.00
.0035	.0023	.0016	.0012	.0010	.0008	.0007	.0006	.0005	.0005	.0005	.0005	8.20
.0033	.0022	.0016	.0012	.0009	.0007	.0006	.0006	.0005	.0005	.0004	.0004	8.40
.0032	.0021	.0015	.0011	.0009	.0007	.0006	.0005	.0005	.0004	.0004	.0004	8.60
.0031	.0020	.0014	.0011	.0008	.0007	.0006	.0005	.0004	.0004	.0004	.0004	8.80
.0030	.0020	.0014	.0010	.0008	.0006	.0006	.0005	.0004	.0004	.0004	.0004	9.00
.0028	.0019	.0013	.0010	.0008	.0006	.0005	.0005	.0004	.0004	.0004	.0004	9.20
.0027	.0018	.0013	.0009	.0007	.0006	.0005	.0004	.0004	.0004	.0004	.0004	9.40
.0026	.0017	.0012	.0009	.0007	.0006	.0005	.0004	.0004	.0004	.0003	.0003	9.60
.0025	.0017	.0012	.0009	.0007	.0006	.0005	.0004	.0004	.0003	.0003	.0003	9.80
.0024	.0016	.0011	.0008	.0006	.0005	.0004	.0004	.0004	.0003	.0003	.0003	10.00
.0024	.0016	.0011	.0008	.0006	.0005	.0004	.0004	.0003	.0003	.0003	.0003	10.20
.0023	.0015	.0010	.0008	.0006	.0005	.0004	.0004	.0003	.0003	.0003	.0003	10.40
.0022	.0014	.0010	.0008	.0006	.0005	.0004	.0004	.0003	.0003	.0003	.0003	10.60
.0021	.0014	.0010	.0007	.0006	.0005	.0004	.0003	.0003	.0003	.0003	.0003	10.80
.0021	.0014	.0010	.0007	.0006	.0004	.0004	.0003	.0003	.0003	.0003	.0003	11.00
.0020	.0013	.0009	.0007	.0005	.0004	.0004	.0003	.0003	.0003	.0002	.0002	11.20
.0019	.0013	.0009	.0007	.0005	.0004	.0004	.0003	.0003	.0003	.0002	.0002	11.40
.0019	.0012	.0009	.0006	.0005	.0004	.0003	.0003	.0003	.0002	.0002	.0002	11.60
.0018	.0012	.0008	.0006	.0005	.0004	.0003	.0003	.0003	.0002	.0002	.0002	11.80
.0018	.0012	.0008	.0006	.0005	.0004	.0003	.0003	.0002	.0002	.0002	.0002	12.00
.0017	.0011	.0008	.0006	.0004	.0004	.0003	.0003	.0002	.0002	.0002	.0002	12.20
.0016	.0011	.0008	.0006	.0004	.0004	.0003	.0003	.0002	.0002	.0002	.0002	12.40
.0016	.0010	.0007	.0005	.0004	.0003	.0003	.0002	.0002	.0002	.0002	.0002	12.60
.0016	.0010	.0007	.0005	.0004	.0003	.0003	.0002	.0002	.0002	.0002	.0002	12.80
.0015	.0010	.0007	.0005	.0004	.0003	.0003	.0002	.0002	.0002	.0002	.0002	13.00
.0015	.0010	.0007	.0005	.0004	.0003	.0003	.0002	.0002	.0002	.0002	.0002	13.20
.0014	.0009	.0006	.0005	.0004	.0003	.0003	.0002	.0002	.0002	.0002	.0002	13.40
.0014	.0009	.0006	.0005	.0004	.0003	.0002	.0002	.0002	.0002	.0002	.0002	13.60
.0014	.0009	.0006	.0005	.0004	.0003	.0002	.0002	.0002	.0002	.0002	.0002	13.80
.0013	.0009	.0006	.0004	.0003	.0003	.0002	.0002	.0002	.0002	.0002	.0002	14.00
.0013	.0008	.0006	.0004	.0003	.0003	.0002	.0002	.0002	.0002	.0002	.0002	14.20
.0013	.0008	.0006	.0004	.0003	.0003	.0002	.0002	.0002	.0002	.0002	.0002	14.40
.0012	.0008	.0006	.0004	.0003	.0003	.0002	.0002	.0002	.0002	.0002	.0002	14.60
.0012	.0008	.0005	.0004	.0003	.0002	.0002	.0002	.0002	.0002	.0002	.0002	14.80
.0012	.0008	.0005	.0004	.0003	.0002	.0002	.0002	.0002	.0002	.0001	.0001	15.00
.0011	.0007	.0005	.0004	.0003	.0002	.0002	.0002	.0002	.0002	.0001	.0001	15.20
.0011	.0007	.0005	.0004	.0003	.0002	.0002	.0002	.0002	.0001	.0001	.0001	15.40
.0011	.0007	.0005	.0004	.0003	.0002	.0002	.0002	.0002	.0001	.0001	.0001	15.60
.0011	.0007	.0005	.0004	.0003	.0002	.0002	.0002	.0002	.0001	.0001	.0001	15.80
.0010	.0007	.0005	.0003	.0003	.0002	.0002	.0002	.0001	.0001	.0001	.0001	16.00
.0010	.0006	.0005	.0003	.0003	.0002	.0002	.0002	.0001	.0001	.0001	.0001	16.20
.0010	.0006	.0004	.0003	.0002	.0002	.0002	.0002	.0001	.0001	.0001	.0001	16.40
.0010	.0006	.0004	.0003	.0002	.0002	.0002	.0002	.0001	.0001	.0001	.0001	16.60
.0009	.0006	.0004	.0003	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	16.80
.0009	.0006	.0004	.0003	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	17.00
.0009	.0006	.0004	.0003	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	17.20
.0009	.0006	.0004	.0003	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	17.40
.0009	.0006	.0004	.0003	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	17.60
.0008	.0006	.0004	.0003	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	17.80
.0008	.0005	.0004	.0003	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	18.00
.0008	.0005	.0004	.0003	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	18.20
.0008	.0005	.0004	.0003	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	18.40
.0008	.0005	.0004	.0003	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	18.60
.0008	.0005	.0003	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	18.80
.0008	.0005	.0003	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	19.00
.0007	.0005	.0003	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	19.20
.0007	.0005	.0003	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	19.40
.0007	.0005	.0003	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	19.60
.0007	.0004	.0003	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	.0001	19.80
.0007	.0004	.0003	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	.0001	20.00

TABLE IV - COMPTON SCATTERING ABSORPTION COEFFICIENT $\sigma(\alpha)$, COMPUTED FROM EQUATION (5)

E_o (Mev)	$\sigma(\alpha)$ (sq cm/ electron)	E_o (Mev)	$\sigma(\alpha)$ (sq cm/ electron)	E_o (Mev)	$\sigma(\alpha)$ (sq cm/ electron)	E_o (Mev)	$\sigma(\alpha)$ (sq cm/ electron)
0.01	1.5513	3.90	0.1955	9.50	0.1061	15.10	0.0752
.02	1.3080	4.00	.1923	9.60	.1053	15.20	.0748
.03	1.1780	4.10	.1893	9.70	.1045	15.30	.0744
.04	1.1539	4.20	.1863	9.80	.1037	15.40	.0741
.05	1.1254	4.30	.1835	9.90	.1029	15.50	.0737
.06	1.0949	4.40	.1807	10.00	.1022	15.60	.0734
.07	1.0657	4.50	.1781	10.10	.1014	15.70	.0730
.08	1.0355	4.60	.1755	10.20	.1007	15.80	.0726
.09	1.0108	4.70	.1730	10.30	.1000	15.90	.0723
.10	.9877	4.80	.1706	10.40	.0993	16.00	.0720
.15	.8890	4.90	.1683	10.50	.0986	16.10	.0716
.20	.8147	5.00	.1660	10.60	.0979	16.20	.0713
.25	.7561	5.10	.1639	10.70	.0972	16.30	.0709
.30	.7083	5.20	.1617	10.80	.0966	16.40	.0706
.35	.6686	5.30	.1597	10.90	.0959	16.50	.0703
.40	.6346	5.40	.1577	11.00	.0953	16.60	.0700
.45	.6052	5.50	.1557	11.10	.0946	16.70	.0696
.50	.5795	5.60	.1538	11.20	.0940	16.80	.0693
.55	.5566	5.70	.1520	11.30	.0934	16.90	.0690
.60	.5360	5.80	.1502	11.40	.0928	17.00	.0687
.65	.5175	5.90	.1484	11.50	.0922	17.10	.0684
.70	.5006	6.00	.1467	11.60	.0916	17.20	.0681
.75	.4851	6.10	.1451	11.70	.0910	17.30	.0678
.80	.4709	6.20	.1435	11.80	.0905	17.40	.0675
.85	.4576	6.30	.1419	11.90	.0899	17.50	.0672
.90	.4453	6.40	.1403	12.00	.0893	17.60	.0669
.95	.4340	6.50	.1389	12.10	.0888	17.70	.0666
1.00	.4232	6.60	.1374	12.20	.0882	17.80	.0663
1.10	.4037	6.70	.1360	12.30	.0877	17.90	.0660
1.20	.3864	6.80	.1346	12.40	.0872	18.00	.0657
1.30	.3708	6.90	.1332	12.50	.0867	18.10	.0655
1.40	.3567	7.00	.1319	12.60	.0862	18.20	.0652
1.50	.3438	7.10	.1306	12.70	.0856	18.30	.0649
1.60	.3321	7.20	.1293	12.80	.0851	18.40	.0646
1.70	.3212	7.30	.1280	12.90	.0847	18.50	.0644
1.80	.3112	7.40	.1268	13.00	.0842	18.60	.0641
1.90	.3020	7.50	.1256	13.10	.0837	18.70	.0638
2.00	.2933	7.60	.1244	13.20	.0832	18.80	.0636
2.10	.2852	7.70	.1233	13.30	.0827	18.90	.0633
2.20	.2776	7.80	.1222	13.40	.0823	19.00	.0631
2.30	.2706	7.90	.1211	13.50	.0818	19.10	.0628
2.40	.2639	8.00	.1200	13.60	.0814	19.20	.0626
2.50	.2575	8.10	.1189	13.70	.0809	19.30	.0623
2.60	.2516	8.20	.1179	13.80	.0805	19.40	.0621
2.70	.2459	8.30	.1169	13.90	.0800	19.50	.0618
2.80	.2406	8.40	.1159	14.00	.0796	19.60	.0616
2.90	.2355	8.50	.1149	14.10	.0792	19.70	.0613
3.00	.2306	8.60	.1140	14.20	.0788	19.80	.0611
3.10	.2260	8.70	.1130	14.30	.0783	19.90	.0608
3.20	.2216	8.80	.1121	14.40	.0779	20.00	.0606
3.30	.2174	8.90	.1112	14.50	.0775		
3.40	.2133	9.00	.1103	14.60	.0771		
3.50	.2095	9.10	.1094	14.70	.0767		
3.60	.2058	9.20	.1085	14.80	.0763		
3.70	.2022	9.30	.1077	14.90	.0760		
3.80	.1988	9.40	.1069	15.00	.0756		

1203

TABLE V - AUXILIARY TABLE FOR COMPTON SCATTERING COEFFICIENT σ IN TABLE IV

Z	$\frac{2\pi N_e e^4}{m^2 c^4}$	Z	$\frac{2\pi N_e e^4}{m^2 c^4}$	Z	$\frac{2\pi N_e e^4}{m^2 c^4}$
3	0.0694	26	1.100	[1,i]50	0.7343
4	.2466	27	1.225	[1]51	.8422
[1,a]5	.3472	28	1.276	52	.7643
[1,b]5	.3403	[1]29	1.224	[1]53	.6188
[1,a]6	.3000	30	.9847	[1]55	.2325
[1,c]6	.3378	[1]31	.7925	56	.4289
[1,d]6	.5270	[1]32	.7233	57	.7585
11	.1395	33	.7587	72	1.612
12	.2581	34	.6212	[j]73	2.014
[1]13	.3915	37	.1993	[k]73	1.758
14	.3599	[1]38	.3389	74	2.334
[e]15	.2649	39	.7264	75	2.484
[f]15	.3202	40	.8435	76	2.700
[g]16	.3105	[1]41	1.114	77	2.687
[h]16	.2936	42	1.342	[1]78	2.567
[1]19	.1256	[1]44	1.599	[1]79	2.324
20	.2325	[1]45	1.630	80	1.624
[1]21	.3499	[1]46	1.490	81	1.412
22	.6213	47	1.375	82	1.349
[1]23	.7597	48	1.109	[1]83	1.162
[1]24	.9598	[1]49	.9343	88	.5851
25	.9849	[1,e]50	.9097	[1]90	1.282
				92	2.172

[a]Amorphous
[b]Crystals
[c]Graphite
[d]Diamond
[e]White
[f]Red
[g]Rhombic
[h]Monoclinic
[i]Gray
[j]Metal
[k]Powder

[1]These values have been calculated using densities in reference 22 because the densities listed in different sections of reference 20 disagree among themselves by as much as 25 percent.

NACA

TABLE VI - PHOTOELECTRIC ABSORPTION COEFFICIENT

Z	E_Q 2.00	2.10	2.20	2.30	2.40	2.50	2.60	2.70	2.80	2.90	3.00	3.10	3.20	3.30	3.40	3.50	3.60	3.70
14	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	.0001	.0001	.0001	.0001	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
16	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0000	.0000	.0000	.0000	.0000	.0000
17	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
18	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
19	.0002	.0002	.0002	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
20	.0003	.0003	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	.0001
21	.0003	.0003	.0003	.0003	.0003	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0001
22	.0004	.0004	.0004	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
23	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002	.0002	.0002
24	.0006	.0006	.0006	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003	.0003	.0003	.0003	.0003	.0003
25	.0008	.0007	.0007	.0006	.0006	.0006	.0005	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0003
26	.0009	.0009	.0008	.0008	.0007	.0007	.0006	.0006	.0006	.0006	.0005	.0005	.0005	.0005	.0005	.0004	.0004	.0004
27	.0011	.0010	.0010	.0009	.0009	.0008	.0008	.0007	.0007	.0007	.0006	.0006	.0006	.0006	.0005	.0005	.0005	.0005
28	.0013	.0012	.0012	.0011	.0010	.0010	.0009	.0009	.0008	.0008	.0008	.0007	.0007	.0007	.0006	.0006	.0006	.0006
29	.0016	.0015	.0014	.0013	.0012	.0011	.0011	.0010	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0007	.0007	.0007
30	.0018	.0017	.0016	.0015	.0014	.0013	.0013	.0012	.0011	.0011	.0010	.0010	.0010	.0009	.0009	.0009	.0008	.0008
31	.0021	.0020	.0019	.0017	.0016	.0016	.0015	.0014	.0013	.0013	.0012	.0012	.0011	.0011	.0010	.0010	.0010	.0009
32	.0025	.0023	.0022	.0020	.0019	.0018	.0017	.0016	.0015	.0015	.0014	.0013	.0013	.0012	.0012	.0012	.0011	.0011
33	.0029	.0027	.0025	.0023	.0022	.0021	.0020	.0019	.0018	.0017	.0016	.0016	.0015	.0014	.0014	.0013	.0013	.0012
34	.0033	.0031	.0029	.0027	.0025	.0024	.0023	.0021	.0020	.0020	.0019	.0018	.0017	.0016	.0016	.0015	.0015	.0014
35	.0038	.0035	.0033	.0031	.0029	.0027	.0026	.0025	.0023	.0022	.0021	.0020	.0020	.0019	.0018	.0018	.0017	.0016
36	.0043	.0040	.0037	.0035	.0033	.0031	.0029	.0028	.0027	.0025	.0024	.0023	.0022	.0022	.0021	.0020	.0019	.0019
37	.0048	.0045	.0042	.0040	.0037	.0035	.0033	.0032	.0030	.0029	.0028	.0026	.0025	.0024	.0024	.0023	.0022	.0021
38	.0055	.0051	.0048	.0045	.0042	.0040	.0038	.0036	.0034	.0033	.0031	.0030	.0029	.0028	.0027	.0026	.0025	.0024
39	.0062	.0058	.0054	.0051	.0048	.0045	.0043	.0041	.0039	.0037	.0035	.0034	.0032	.0031	.0030	.0029	.0028	.0027
40	.0069	.0065	.0060	.0057	.0054	.0051	.0048	.0046	.0043	.0041	.0040	.0038	.0036	.0035	.0034	.0033	.0031	.0030
41	.0078	.0072	.0068	.0064	.0060	.0057	.0054	.0051	.0049	.0046	.0044	.0043	.0041	.0039	.0038	.0036	.0035	.0034
42	.0087	.0081	.0076	.0071	.0067	.0063	.0060	.0057	.0054	.0052	.0050	.0048	.0046	.0044	.0042	.0041	.0039	.0038
43	.0097	.0090	.0084	.0079	.0075	.0071	.0067	.0064	.0061	.0058	.0055	.0053	.0051	.0049	.0047	.0045	.0044	.0042
44	.0107	.0100	.0094	.0088	.0083	.0078	.0074	.0071	.0067	.0064	.0061	.0059	.0057	.0054	.0052	.0050	.0049	.0047
45	.0119	.0111	.0104	.0097	.0092	.0087	.0082	.0078	.0075	.0071	.0068	.0065	.0063	.0060	.0058	.0056	.0054	.0052
46	.0132	.0123	.0115	.0108	.0102	.0096	.0091	.0087	.0083	.0079	.0075	.0072	.0069	.0067	.0064	.0062	.0060	.0058
47	.0145	.0135	.0127	.0119	.0112	.0106	.0101	.0096	.0091	.0087	.0083	.0080	.0077	.0074	.0071	.0068	.0066	.0064
48	.0160	.0149	.0139	.0131	.0123	.0117	.0111	.0105	.0100	.0096	.0092	.0088	.0084	.0081	.0078	.0075	.0073	.0070
49	.0175	.0163	.0153	.0144	.0136	.0128	.0122	.0116	.0110	.0105	.0101	.0097	.0093	.0089	.0086	.0083	.0080	.0077
50	.0192	.0179	.0168	.0158	.0149	.0141	.0133	.0127	.0121	.0115	.0110	.0106	.0102	.0098	.0094	.0091	.0088	.0085
51	.0210	.0196	.0183	.0172	.0163	.0154	.0146	.0139	.0132	.0126	.0121	.0116	.0111	.0107	.0103	.0099	.0096	.0093
52	.0229	.0214	.0200	.0188	.0178	.0168	.0159	.0152	.0144	.0138	.0132	.0127	.0122	.0117	.0113	.0109	.0105	.0101
53	.0250	.0233	.0218	.0205	.0194	.0183	.0174	.0165	.0158	.0150	.0144	.0138	.0133	.0128	.0123	.0119	.0114	.0111
54	.0272	.0254	.0238	.0223	.0211	.0199	.0189	.0180	.0171	.0164	.0157	.0150	.0144	.0139	.0134	.0129	.0125	.0120
55	.0295	.0275	.0258	.0243	.0229	.0217	.0206	.0195	.0186	.0178	.0170	.0163	.0157	.0151	.0145	.0140	.0135	.0131
56	.0320	.0299	.0280	.0263	.0248	.0235	.0223	.0212	.0202	.0193	.0185	.0177	.0170	.0164	.0158	.0152	.0147	.0142
57	.0347	.0323	.0303	.0285	.0269	.0254	.0241	.0230	.0219	.0209	.0200	.0192	.0185	.0178	.0171	.0165	.0159	.0154
58	.0375	.0350	.0328	.0308	.0291	.0275	.0261	.0248	.0237	.0226	.0217	.0208	.0200	.0192	.0185	.0179	.0172	.0167
59	.0404	.0377	.0354	.0333	.0314	.0297	.0282	.0268	.0256	.0245	.0234	.0225	.0216	.0208	.0200	.0193	.0186	.0180
60	.0436	.0407	.0381	.0359	.0338	.0320	.0304	.0289	.0276	.0264	.0253	.0242	.0233	.0224	.0216	.0208	.0201	.0195
61	.0469	.0438	.0410	.0386	.0364	.0345	.0328	.0312	.0297	.0284	.0272	.0261	.0251	.0241	.0233	.0224	.0217	.0210
62	.0504	.0470	.0441	.0415	.0392	.0371	.0352	.0335	.0320	.0306	.0293	.0281	.0270	.0260	.0250	.0242	.0233	.0226
63	.0541	.0505	.0474	.0446	.0421	.0398	.0378	.0360	.0344	.0328	.0315	.0302	.0290	.0279	.0269	.0260	.0251	.0243
64	.0580	.0541	.0508	.0478	.0451	.0427	.0406	.0386	.0369	.0352	.0338	.0324	.0311	.0300	.0289	.0279	.0269	.0260
65	.0621	.0580	.0544	.0512	.0483	.0458	.0435	.0414	.0395	.0378	.0362	.0347	.0334	.0321	.0310	.0299	.0289	.0279
66	.0664	.0620	.0582	.0548	.0517	.0490	.0465	.0443	.0423	.0404	.0387	.0372	.0357	.0344	.0331	.0320	.0309	.0299
67	.0709	.0662	.0621	.0585	.0553	.0524	.0497	.0474	.0452	.0432	.0414	.0398	.0382	.0368	.0355	.0342	.0331	.0320
68	.0757	.0707	.0663	.0625	.0590	.0559	.0531	.0506	.0483	.0462	.0442	.0425	.0408	.0393	.0379	.0366	.0353	.0342
69	.0806	.0753	.0707	.0666	.0629	.0596	.0567	.0540	.0515	.0493	.0472	.0453	.0436	.0419	.0404	.0390	.0377	.0365
70	.0858	.0802	.0753	.0709	.0670	.0635	.0604	.0575	.0549	.0525	.0503	.0483	.0464	.0447	.0431	.0416	.0402	.0389
71	.0913	.0853	.0801	.0754	.0713	.0676	.0642	.0612	.0584	.0559	.0536	.0514	.0494	.0476	.0459	.0443	.0428	.0414
72	.0969	.0906	.0851	.0802	.0758	.0719	.0683	.0651	.0621	.0594	.0570	.0547	.0526	.0507	.0488	.0472	.0456	.0441
73	.1029	.0962	.0903	.0851	.0805	.0763	.0725	.0691	.0660	.0632	.0605	.0581	.0559	.0538	.0519	.0501	.0485	.0469
74	.1091	.1020	.0958	.0903	.0854	.0810	.0770	.0734	.0701	.0670	.0643	.0617	.0594	.0572	.0551	.0532	.0515	.0498
75	.1155	.1081	.1015	.0957	.0905	.0858	.0816	.0778	.0743	.0711	.0682	.0655	.0630	.0606	.0585	.0565	.0546	.0528
76	.1222	.1144	.1074	.1013	.0958	.0909	.0864	.0824	.0787	.0753	.0722	.0694	.0667	.0643	.0620	.0599	.0579	.0560
77	.1292	.1209	.1136	.1071	.1013	.0961	.0914	.0872	.0833	.0797	.0764	.0734	.0706	.0681	.0656	.0634	.0613	.0593
78	.1365	.1277	.1200	.1132	.1071	.1016	.0967	.0922	.0881	.0843	.0809	.0777	.0747	.0720	.0695	.0671	.0649	.0628
79	.1440	.1348	.1267	.1195	.1131	.1073	.1021	.0974	.0930	.0891	.0854	.0821	.0790	.0761	.0734	.0709	.0686	.0664
80	.1518	.1422	.1336	.1261	.1193	.1132	.1078	.1028	.0982	.0940	.0902	.0867	.0834	.0804	.0776	.0749	.0725	.0702
81	.1599	.1498	.1408	.1329	.1258	.1194	.1136	.1084	.1036	.0992	.0952	.0915	.0880	.0848	.0818	.0791	.0765	.0741
82	.1683	.1577	.1483	.1399	.1325	.1258	.1197	.1142	.1092	.1046	.1003	.0964	.0928	.0894	.0863	.0834	.0807	.0781
83	.1770	.1658	.1560	.1472	.1394	.1324	.1260	.1202	.1149	.1101	.1057	.1015	.0977	.0942	.0909	.0879	.0851	.0823
84	.1859	.1743	.1640	.1548	.1466	.1392	.1325	.1265	.1209	.1159	.1112	.1069	.1029	.0992	.0957	.0925	.0895	.0867
85	.1952	.1830	.1722	.1626	.1540	.1463	.1393	.1329	.1271	.1218	.1169	.1124	.1082	.1043	.1007	.0973	.0942	.0912
86	.2048	.1920	.1807	.1707	.1617	.1536	.1463	.1396	.1336	.1280	.1229	.1181	.1137	.1097	.1059	.1023	.0990	.0959
87	.2146	.2013	.1895	.1790	.1696	.1612	.1535	.1466	.1402	.1344	.1290	.1240	.1194	.1152	.1112	.1075	.1040	.1008
88	.2248	.2109	.1986	.1876	.1778	.1690	.1610	.1537	.1470	.1409	.1353	.1301	.1253	.1209	.1167	.1128	.1092	.1058
89	.2352	.2207	.2079	.1965	.1862	.1770	.1687	.1611	.1541	.1477	.1419	.1365	.1314	.1268	.1224	.1184	.1146	.1110
90	.2460	.2309	.2175	.2056	.1949	.1853	.1766	.1687	.1614	.1548	.1486	.1430	.1377	.1328	.1283	.1241	.1201	.1164
91	.2570	.2413	.2274	.2150	.2039	.1938	.1848	.1765	.1689	.1620	.1556	.1497	.1442	.1391	.1344	.1299	.1258	.1219
92	.2683	.2520	.2375	.2246	.2131	.2026	.1932	.1846	.1767	.1694	.1628	.1566	.1509	.1456	.1406	.1360	.1317	.1276
93	.2800	.2630	.2479	.2345	.2225	.2117	.2018	.1928	.1846	.1771	.1702	.1637	.1578	.1523	.1471	.1423	.1378	.1335
94	.2919	.2743	.2586	.2447	.2322	.2209	.2107	.2014	.1928	.1850	.1778	.1711	.1649	.1591	.1537	.1487	.1440	.1396
95	.3041	.2858	.2696	.2551	.2422	.2304	.2198	.2131	.2012	.1931	.1856	.1786	.1722	.1662	.1606	.1554	.1505	.1459
96	.3166	.2976	.2808	.2658	.2524	.2402	.2292	.2191	.2099	.2014	.1936	.1864	.1797	.1734	.1676	.1622	.1571	.1523

1203

1203

$\tau_K \times 10^{23}$ COMPUTED FROM EQUATION (8)

E_o																		
3.80	3.90	4.00	4.10	4.20	4.30	4.40	4.50	4.60	4.70	4.80	4.90	5.00	5.10	5.20	5.30	5.40	5.50	z
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	14
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	15
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	16
.0001	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	17
.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0000	.0000	.0000	.0000	.0000	.0000	18
.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	19
.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	20
.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	21
.0002	.0002	.0002	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	22
.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0001	.0001	.0001	23
.0003	.0003	.0003	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	24
.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	25
.0004	.0004	.0004	.0004	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	26
.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0003	.0003	.0003	.0003	.0003	.0003	.0003	27
.0006	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	28
.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0004	.0004	.0004	.0004	29
.0008	.0007	.0007	.0007	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005	.0005	.0005	30
.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007	.0007	.0007	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0006	31
.0010	.0010	.0010	.0009	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0008	.0007	.0007	.0007	.0007	.0007	.0007	32
.0012	.0012	.0011	.0011	.0011	.0010	.0010	.0010	.0009	.0009	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0008	33
.0014	.0013	.0013	.0013	.0012	.0012	.0012	.0011	.0011	.0011	.0010	.0010	.0010	.0010	.0009	.0009	.0009	.0009	34
.0016	.0015	.0015	.0014	.0014	.0014	.0013	.0013	.0012	.0012	.0012	.0012	.0011	.0011	.0011	.0011	.0010	.0010	35
.0018	.0017	.0017	.0016	.0016	.0015	.0015	.0015	.0014	.0014	.0014	.0013	.0013	.0013	.0012	.0012	.0012	.0012	36
.0020	.0020	.0019	.0019	.0018	.0018	.0017	.0017	.0016	.0016	.0015	.0015	.0015	.0014	.0014	.0014	.0013	.0013	37
.0023	.0022	.0022	.0021	.0020	.0020	.0019	.0019	.0018	.0018	.0017	.0017	.0017	.0016	.0016	.0015	.0015	.0015	38
.0026	.0025	.0024	.0024	.0023	.0022	.0022	.0021	.0021	.0020	.0020	.0019	.0019	.0018	.0018	.0017	.0017	.0017	39
.0029	.0028	.0028	.0027	.0026	.0025	.0025	.0024	.0023	.0023	.0022	.0022	.0021	.0021	.0020	.0020	.0019	.0019	40
.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0027	.0026	.0025	.0025	.0024	.0024	.0023	.0023	.0022	.0022	.0021	41
.0037	.0036	.0034	.0033	.0032	.0032	.0031	.0030	.0029	.0028	.0028	.0027	.0026	.0026	.0025	.0025	.0024	.0024	42
.0041	.0040	.0038	.0037	.0036	.0035	.0034	.0033	.0032	.0032	.0031	.0030	.0029	.0029	.0028	.0027	.0027	.0026	43
.0046	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036	.0035	.0034	.0033	.0033	.0032	.0031	.0031	.0030	.0029	44
.0051	.0049	.0047	.0046	.0045	.0043	.0042	.0041	.0040	.0039	.0038	.0037	.0036	.0035	.0035	.0034	.0033	.0032	45
.0056	.0054	.0052	.0051	.0049	.0048	.0047	.0046	.0044	.0043	.0042	.0041	.0040	.0039	.0038	.0037	.0037	.0036	46
.0062	.0060	.0058	.0056	.0055	.0053	.0052	.0050	.0049	.0048	.0047	.0045	.0044	.0043	.0042	.0041	.0041	.0040	47
.0068	.0066	.0064	.0062	.0060	.0058	.0057	.0055	.0054	.0053	.0051	.0050	.0049	.0048	.0047	.0046	.0045	.0044	48
.0075	.0072	.0070	.0068	.0066	.0064	.0063	.0061	.0059	.0058	.0056	.0055	.0054	.0052	.0051	.0050	.0049	.0048	49
.0082	.0079	.0077	.0075	.0073	.0071	.0069	.0067	.0065	.0063	.0062	.0060	.0059	.0058	.0056	.0055	.0054	.0053	50
.0090	.0087	.0084	.0082	.0079	.0077	.0075	.0073	.0071	.0069	.0068	.0066	.0065	.0063	.0062	.0060	.0059	.0058	51
.0098	.0095	.0092	.0089	.0087	.0084	.0082	.0080	.0078	.0076	.0074	.0072	.0071	.0069	.0067	.0066	.0065	.0063	52
.0107	.0104	.0101	.0098	.0095	.0092	.0090	.0087	.0085	.0083	.0081	.0079	.0077	.0075	.0074	.0072	.0070	.0069	53
.0117	.0113	.0110	.0106	.0103	.0100	.0098	.0095	.0093	.0900	.0088	.0086	.0084	.0082	.0080	.0078	.0077	.0075	54
.0127	.0123	.0119	.0116	.0112	.0109	.0106	.0103	.0101	.0098	.0096	.0094	.0091	.0089	.0087	.0085	.0083	.0082	55
.0138	.0133	.0129	.0126	.0122	.0119	.0115	.0112	.0109	.0107	.0104	.0102	.0099	.0097	.0095	.0093	.0091	.0089	56
.0149	.0145	.0140	.0136	.0132	.0128	.0125	.0122	.0119	.0116	.0113	.0110	.0108	.0105	.0103	.0100	.0098	.0096	57
.0161	.0156	.0152	.0147	.0143	.0139	.0135	.0132	.0128	.0125	.0122	.0119	.0116	.0114	.0111	.0109	.0106	.0104	58
.0174	.0169	.0164	.0159	.0155	.0150	.0146	.0142	.0139	.0135	.0132	.0129	.0126	.0123	.0120	.0118	.0115	.0113	59
.0188	.0182	.0177	.0172	.0167	.0162	.0158	.0154	.0150	.0146	.0143	.0139	.0136	.0133	.0130	.0127	.0124	.0122	60
.0203	.0197	.0191	.0185	.0180	.0175	.0170	.0166	.0162	.0158	.0154	.0150	.0147	.0143	.0140	.0137	.0134	.0131	61
.0218	.0212	.0205	.0199	.0194	.0188	.0183	.0178	.0174	.0170	.0165	.0162	.0158	.0154	.0151	.0148	.0144	.0141	62
.0235	.0228	.0221	.0214	.0208	.0203	.0197	.0192	.0187	.0182	.0178	.0174	.0170	.0166	.0162	.0159	.0155	.0152	63
.0252	.0244	.0237	.0230	.0224	.0217	.0212	.0206	.0201	.0196	.0191	.0187	.0182	.0178	.0174	.0170	.0167	.0163	64
.0270	.0262	.0254	.0247	.0240	.0233	.0227	.0221	.0215	.0210	.0205	.0200	.0196	.0191	.0187	.0183	.0179	.0175	65
.0290	.0281	.0272	.0264	.0257	.0250	.0243	.0237	.0231	.0225	.0220	.0214	.0210	.0205	.0200	.0196	.0192	.0188	66
.0310	.0300	.0291	.0283	.0275	.0267	.0260	.0253	.0247	.0241	.0235	.0230	.0224	.0219	.0214	.0210	.0205	.0201	67
.0331	.0321	.0311	.0302	.0294	.0286	.0278	.0271	.0264	.0258	.0251	.0245	.0240	.0234	.0229	.0224	.0220	.0215	68
.0353	.0343	.0332	.0323	.0314	.0305	.0297	.0289	.0282	.0275	.0268	.0262	.0256	.0250	.0245	.0240	.0235	.0230	69
.0377	.0365	.0355	.0344	.0335	.0326	.0317	.0309	.0301	.0293	.0286	.0280	.0273	.0267	.0261	.0256	.0250	.0245	70
.0401	.0389	.0378	.0367	.0357	.0347	.0338	.0329	.0321	.0313	.0305	.0298	.0291	.0285	.0278	.0272	.0267	.0261	71
.0427	.0414	.0402	.0390	.0380	.0369	.0359	.0350	.0341	.0333	.0325	.0317	.0310	.0303	.0297	.0290	.0284	.0278	72
.0454	.0440	.0427	.0415	.0404	.0393	.0382	.0372	.0363	.0354	.0346	.0338	.0330	.0323	.0315	.0309	.0302	.0296	73
.0482	.0468	.0454	.0441	.0429	.0417	.0406	.0396	.0386	.0376	.0367	.0359	.0351	.0343	.0335	.0328	.0321	.0315	74
.0512	.0497	.0482	.0468	.0455	.0443	.0431	.0420	.0410	.0400	.0390	.0381	.0372	.0364	.0356	.0348	.0341	.0334	75
.0543	.0526	.0511	.0496	.0483	.0470	.0457	.0446	.0434	.0424	.0414	.0404	.0395	.0386	.0378	.0370	.0362	.0354	76
.0575	.0558	.0541	.0526	.0511	.0498	.0485	.0472	.0460	.0449	.0438	.0428	.0419	.0409	.0400	.0392	.0384	.0376	77
.0609	.0590	.0573	.0557	.0541	.0527	.0513	.0500	.0487	.0476	.0464	.0453	.0443	.0433	.0424	.0415	.0406	.0398	78
.0643	.0624	.0606	.0589	.0573	.0557	.0543	.0529	.0516	.0503	.0491	.0480	.0469	.0459	.0449	.0439	.0430	.0421	79
.0680	.0660	.0640	.0622	.0605	.0589	.0573	.0559	.0545	.0532	.0519	.0507	.0496	.0485	.0474	.0464	.0455	.0445	80
.0718	.0696	.0676	.0657	.0639	.0622	.0606	.0590	.0576	.0562	.0548	.0536	.0524	.0512	.0501	.0490	.0480	.0470	81
.0757	.0734	.0713	.0693	.0674	.0656	.0639	.0623	.0607	.0593	.0579	.0565	.0553	.0541	.0529	.0518	.0507	.0497	82
.0798	.0774	.0752	.0731	.0711	.0692	.0674	.0657	.0641	.0625	.0610	.0596	.0583	.0570	.0558	.0546	.0535	.0524	83
.0840	.0815	.0792	.0770	.0749	.0729	.0710	.0692	.0675	.0659	.0643	.0628	.0614	.0601	.0588	.0576	.0564	.0552	84
.0884	.0858	.0833	.0810	.0788	.0767	.0747	.0728	.0711	.0694	.0677	.0662	.0647	.0633	.0619	.0606	.0594	.0582	85
.0930	.0902	.0876	.0852	.0829	.0807	.0786	.0766	.0748	.0730	.0713	.0696	.0681	.0666	.0652	.0638	.0625	.0612	86
.0977	.0948	.0921	.0895	.0871	.0848	.0826	.0806	.0786	.0767	.0749	.0732	.0716	.0700	.0685	.0671	.0657	.0644	87
.1026	.0996	.0967	.0940	.0915	.0891	.0868	.0846	.0826	.0806	.0787	.0769	.0752	.0736	.0720	.0705	.0691	.0677	88
.1076	.1045	.1015	.0987	.0960	.0935	.0911	.0888	.0867	.0846	.0826	.0808	.0790	.0773	.0756	.0740	.0725	.0711	89
.1129	.1096	.1064	.1035	.1007	.0981	.0956	.0932	.0909	.0888	.0867	.0847	.0829	.0811	.0793	.0777	.0761	.0746	90
.1182	.1148	.1115	.1085	.1056	.1028	.1002	.0977	.0953	.0931	.0909	.0889	.0869	.0850	.0832	.0815	.0798	.0782	91
.1238	.1202	.1168	.1136	.1106	.1077	.1049	.1023	.0999	.0975	.0952	.0931	.0910	.0891	.0872	.0854	.0837	.0820	92
.1295	.1258	.1222	.1189	.1157	.1127	.1098	.1071	.1045	.1021	.0997	.0975	.0953	.0933	.0913	.0894	.0876	.0859	93
.1354	.1315	.1278	.1243	.1210	.1179	.1149	.1121	.1094	.1068	.1044	.1020	.0998	.0976	.0956	.0936	.0917	.0899	94
.1415	.1374	.1336	.1300	.1265	.1232	.1201	.1172	.1144	.1117	.1091	.1067	.1043	.1021	.1000	.0979	.0959	.0940	95
.1478	.1435	.1395	.1357	.1321	.1287	.1255	.1224	.1195	.1167	.1140	.1115	.1090	.1067	.1045	.1023	.1003	.0983	96

TABLE VI - PHOTOELECTRIC ABSORPTION COEFFICIENT

Z	E_0 5.60	5.70	5.80	5.90	6.00	6.10	6.20	6.30	6.40	6.50	5.60	6.70	6.80	6.90	7.00	7.10	7.20	7.30
14	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
17	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
18	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
19	.0001	.0001	.0001	.0001	.0001	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
20	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
21	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
22	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
23	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
24	.0002	.0002	.0002	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
25	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
26	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
27	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
28	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003
29	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003
30	.0005	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004
31	.0006	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004
32	.0007	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005
33	.0008	.0007	.0007	.0007	.0007	.0007	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006
34	.0009	.0008	.0008	.0008	.0008	.0008	.0008	.0008	.0007	.0007	.0007	.0007	.0007	.0007	.0007	.0007	.0006	.0006
35	.0010	.0010	.0009	.0009	.0009	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0008	.0008	.0008	.0008	.0007	.0007
36	.0011	.0011	.0011	.0011	.0010	.0010	.0010	.0010	.0010	.0009	.0009	.0009	.0009	.0009	.0009	.0009	.0008	.0008
37	.0013	.0013	.0012	.0012	.0012	.0012	.0011	.0011	.0011	.0011	.0011	.0010	.0010	.0010	.0010	.0010	.0010	.0009
38	.0014	.0014	.0014	.0014	.0013	.0013	.0013	.0013	.0012	.0012	.0012	.0012	.0012	.0011	.0011	.0011	.0011	.0011
39	.0016	.0016	.0016	.0015	.0015	.0015	.0015	.0014	.0014	.0014	.0014	.0013	.0013	.0013	.0013	.0012	.0012	.0012
40	.0018	.0018	.0018	.0017	.0017	.0017	.0016	.0016	.0016	.0015	.0015	.0015	.0015	.0014	.0014	.0014	.0014	.0014
41	.0021	.0020	.0020	.0019	.0019	.0019	.0018	.0018	.0018	.0017	.0017	.0017	.0017	.0016	.0016	.0016	.0015	.0015
42	.0023	.0023	.0022	.0022	.0021	.0021	.0021	.0020	.0020	.0019	.0019	.0019	.0018	.0018	.0018	.0018	.0017	.0017
43	.0026	.0025	.0025	.0024	.0024	.0023	.0023	.0022	.0022	.0022	.0021	.0021	.0021	.0020	.0020	.0020	.0019	.0019
44	.0029	.0028	.0027	.0027	.0026	.0026	.0025	.0025	.0025	.0024	.0024	.0023	.0023	.0023	.0022	.0022	.0021	.0021
45	.0032	.0031	.0030	.0030	.0029	.0029	.0028	.0028	.0027	.0027	.0026	.0026	.0025	.0025	.0025	.0024	.0024	.0023
46	.0035	.0034	.0034	.0033	.0032	.0032	.0031	.0031	.0030	.0030	.0029	.0029	.0028	.0028	.0027	.0027	.0026	.0026
47	.0039	.0038	.0037	.0037	.0036	.0035	.0035	.0034	.0033	.0033	.0032	.0032	.0031	.0031	.0030	.0030	.0029	.0029
48	.0043	.0042	.0041	.0040	.0040	.0039	.0038	.0037	.0037	.0036	.0035	.0035	.0034	.0034	.0033	.0033	.0032	.0032
49	.0047	.0046	.0045	.0044	.0043	.0043	.0042	.0041	.0040	.0040	.0039	.0038	.0038	.0037	.0036	.0036	.0035	.0035
50	.0052	.0051	.0050	.0049	.0048	.0047	.0046	.0045	.0044	.0044	.0043	.0042	.0041	.0041	.0040	.0039	.0039	.0038
51	.0057	.0055	.0054	.0053	.0052	.0051	.0050	.0049	.0049	.0048	.0047	.0046	.0045	.0045	.0044	.0043	.0042	.0042
52	.0062	.0061	.0059	.0058	.0057	.0056	.0055	.0054	.0053	.0052	.0051	.0050	.0050	.0049	.0048	.0047	.0046	.0046
53	.0068	.0066	.0065	.0064	.0062	.0061	.0060	.0059	.0058	.0057	.0056	.0055	.0054	.0053	.0052	.0052	.0051	.0050
54	.0074	.0072	.0071	.0069	.0068	.0067	.0065	.0064	.0063	.0062	.0061	.0060	.0059	.0058	.0057	.0056	.0055	.0054
55	.0080	.0078	.0077	.0075	.0074	.0073	.0071	.0070	.0069	.0068	.0066	.0065	.0064	.0063	.0062	.0061	.0060	.0059
56	.0087	.0085	.0084	.0082	.0080	.0079	.0077	.0076	.0075	.0073	.0072	.0071	.0070	.0069	.0067	.0066	.0065	.0064
57	.0094	.0092	.0091	.0089	.0087	.0086	.0084	.0082	.0081	.0080	.0078	.0077	.0076	.0074	.0073	.0072	.0071	.0070
58	.0102	.0100	.0098	.0096	.0094	.0093	.0091	.0089	.0088	.0086	.0085	.0083	.0082	.0081	.0079	.0078	.0077	.0076
59	.0110	.0108	.0106	.0104	.0102	.0100	.0098	.0097	.0095	.0093	.0092	.0090	.0089	.0087	.0086	.0084	.0083	.0082
60	.0119	.0117	.0115	.0112	.0110	.0108	.0106	.0104	.0102	.0101	.0099	.0097	.0096	.0094	.0093	.0091	.0090	.0088
61	.0129	.0126	.0124	.0121	.0119	.0117	.0114	.0112	.0110	.0109	.0107	.0105	.0103	.0102	.0100	.0098	.0097	.0095
62	.0138	.0136	.0133	.0130	.0128	.0126	.0123	.0121	.0119	.0117	.0115	.0113	.0111	.0109	.0108	.0106	.0104	.0103
63	.0149	.0146	.0143	.0140	.0138	.0135	.0133	.0130	.0128	.0126	.0124	.0122	.0120	.0118	.0116	.0114	.0112	.0110
64	.0160	.0157	.0154	.0151	.0148	.0145	.0143	.0140	.0138	.0135	.0133	.0131	.0128	.0126	.0124	.0122	.0121	.0119
65	.0172	.0168	.0165	.0162	.0159	.0156	.0153	.0150	.0148	.0145	.0143	.0140	.0138	.0136	.0134	.0131	.0129	.0127
66	.0184	.0180	.0177	.0173	.0170	.0167	.0164	.0161	.0158	.0155	.0153	.0150	.0148	.0145	.0143	.0141	.0139	.0137
67	.0197	.0193	.0189	.0186	.0182	.0179	.0176	.0172	.0169	.0166	.0164	.0161	.0158	.0156	.0153	.0151	.0149	.0146
68	.0211	.0206	.0202	.0199	.0195	.0191	.0188	.0184	.0181	.0178	.0175	.0172	.0169	.0167	.0164	.0161	.0159	.0156
69	.0225	.0221	.0216	.0212	.0208	.0204	.0201	.0197	.0194	.0190	.0187	.0184	.0181	.0178	.0175	.0172	.0170	.0167
70	.0240	.0235	.0231	.0226	.0222	.0218	.0214	.0210	.0207	.0203	.0200	.0196	.0193	.0190	.0187	.0184	.0181	.0179
71	.0256	.0251	.0246	.0241	.0237	.0232	.0228	.0224	.0220	.0216	.0213	.0209	.0206	.0203	.0199	.0196	.0193	.0190
72	.0273	.0267	.0262	.0257	.0252	.0248	.0243	.0239	.0235	.0231	.0227	.0223	.0219	.0216	.0212	.0209	.0206	.0203
73	.0290	.0284	.0279	.0273	.0268	.0263	.0259	.0254	.0250	.0245	.0241	.0237	.0233	.0230	.0226	.0223	.0219	.0216
74	.0308	.0302	.0296	.0291	.0285	.0280	.0275	.0270	.0265	.0261	.0257	.0252	.0248	.0244	.0240	.0237	.0233	.0230
75	.0327	.0321	.0315	.0309	.0303	.0297	.0292	.0287	.0282	.0277	.0273	.0268	.0264	.0259	.0255	.0251	.0248	.0244
76	.0347	.0341	.0334	.0328	.0322	.0316	.0310	.0305	.0299	.0294	.0289	.0284	.0280	.0275	.0271	.0267	.0263	.0259
77	.0368	.0361	.0354	.0347	.0341	.0335	.0329	.0323	.0317	.0312	.0307	.0302	.0297	.0292	.0287	.0283	.0279	.0274
78	.0390	.0382	.0375	.0368	.0361	.0355	.0348	.0342	.0336	.0330	.0325	.0320	.0314	.0309	.0305	.0300	.0295	.0291
79	.0413	.0405	.0397	.0389	.0382	.0375	.0369	.0362	.0356	.0350	.0344	.0338	.0333	.0328	.0322	.0317	.0313	.0308
80	.0436	.0428	.0420	.0412	.0404	.0397	.0390	.0383	.0376	.0370	.0364	.0358	.0352	.0346	.0341	.0336	.0331	.0326
81	.0461	.0452	.0443	.0435	.0427	.0419	.0412	.0405	.0398	.0391	.0384	.0378	.0372	.0366	.0360	.0355	.0350	.0344
82	.0487	.0477	.0468	.0459	.0451	.0443	.0435	.0427	.0420	.0413	.0406	.0399	.0393	.0387	.0381	.0375	.0369	.0364
83	.0514	.0504	.0494	.0485	.0476	.0467	.0459	.0451	.0443	.0436	.0428	.0421	.0415	.0408	.0402	.0396	.0390	.0384
84	.0541	.0531	.0521	.0511	.0502	.0493	.0484	.0475	.0467	.0459	.0452	.0444	.0437	.0430	.0424	.0417	.0411	.0405
85	.0570	.0559	.0548	.0538	.0528	.0519	.0510	.0501	.0492	.0484	.0476	.0468	.0461	.0453	.0446	.0440	.0433	.0426
86	.0600	.0588	.0577	.0567	.0556	.0546	.0537	.0527	.0518	.0509	.0501	.0493	.0485	.0477	.0470	.0463	.0456	.0449
87	.0631	.0619	.0607	.0596	.0585	.0575	.0564	.0555	.0545	.0536	.0527	.0519	.0510	.0502	.0495	.0487	.0480	.0473
88	.0663	.0651	.0638	.0626	.0615	.0604	.0593	.0583	.0573	.0564	.0554	.0545	.0537	.0528	.0520	.0512	.0504	.0497
89	.0697	.0683	.0670	.0658	.0646	.0634	.0623	.0612	.0602	.0592	.0582	.0573	.0564	.0555	.0546	.0538	.0530	.0522
90	.0731	.0717	.0704	.0691	.0678	.0666	.0654	.0643	.0632	.0622	.0611	.0601	.0592	.0583	.0574	.0565	.0557	.0548
91	.0767	.0752	.0738	.0724	.0711	.0699	.0686	.0675	.0663	.0652	.0641	.0631	.0621	.0611	.0602	.0593	.0584	.0575
92	.0804	.0789	.0774	.0759	.0746	.0732	.0720	.0707	.0695	.0684	.0673	.0662	.0651	.0641	.0631	.0622	.0612	.0603
93	.0842	.0826	.0810	.0796	.0781	.0767	.0754	.0741	.0728	.0716	.0705	.0693	.0682	.0672	.0661	.0651	.0642	.0632
94	.0881	.0865	.0848	.0833	.0818	.0803	.0789	.0776	.0763	.0750	.0738	.0726	.0715	.0703	.0693	.0682	.0672	.0662
95	.0922	.0904	.0888	.0871	.0856	.0841	.0826	.0812	.0798	.0785	.0772	.0760	.0748	.0736	.0725	.0714	.0704	.0693
96	.0964	.0946	.0928	.0911	.0895	.0879	.0864	.0849	.0835	.0821	.0808	.0795	.0782	.0770	.0758	.0747	.0736	.0725

1203

$T_K \times 10^{23}$, COMPUTED FROM EQUATION (8) - Continued

E_o																		
7.40	7.50	7.60	7.70	7.80	7.90	8.00	8.10	8.20	8.30	8.40	8.50	8.60	8.70	8.80	8.90	9.00	9.10	Z
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	14
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	15
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	16
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	17
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	18
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	19
.0001	.0001	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	20
.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	21
.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	22
.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	23
.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	24
.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	25
.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0001	.0001	.0001	.0001	.0001	26
.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	27
.0003	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	28
.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002	.0002	.0002	.0002	.0002	29
.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	30
.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0003	.0003	.0003	.0003	.0003	.0003	.0003	31
.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	32
.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0004	.0004	.0004	.0004	33
.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005	34
.0007	.0007	.0007	.0007	.0007	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006	35
.0008	.0008	.0008	.0008	.0008	.0008	.0007	.0007	.0007	.0007	.0007	.0007	.0007	.0007	.0007	.0007	.0007	.0006	36
.0009	.0009	.0009	.0009	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0008	.0008	.0008	.0008	.0008	.0007	.0007	37
.0011	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0009	.0009	.0009	.0009	.0009	.0009	.0009	.0009	.0008	.0008	38
.0012	.0012	.0012	.0011	.0011	.0011	.0011	.0011	.0011	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0009	39
.0013	.0013	.0013	.0013	.0013	.0012	.0012	.0012	.0012	.0012	.0012	.0011	.0011	.0011	.0011	.0011	.0011	.0011	40
.0015	.0015	.0015	.0014	.0014	.0014	.0014	.0014	.0013	.0013	.0013	.0013	.0013	.0013	.0012	.0012	.0012	.0012	41
.0017	.0017	.0016	.0016	.0016	.0016	.0015	.0015	.0015	.0015	.0015	.0014	.0014	.0014	.0014	.0014	.0013	.0013	42
.0019	.0018	.0018	.0018	.0018	.0017	.0017	.0017	.0017	.0016	.0016	.0016	.0016	.0016	.0015	.0015	.0015	.0015	43
.0021	.0020	.0020	.0020	.0020	.0019	.0019	.0019	.0019	.0018	.0018	.0018	.0018	.0017	.0017	.0017	.0017	.0017	44
.0023	.0023	.0022	.0022	.0022	.0021	.0021	.0021	.0021	.0020	.0020	.0020	.0020	.0019	.0019	.0019	.0019	.0018	45
.0026	.0025	.0025	.0024	.0024	.0024	.0023	.0023	.0023	.0022	.0022	.0022	.0022	.0021	.0021	.0021	.0021	.0020	46
.0028	.0028	.0027	.0027	.0027	.0026	.0026	.0026	.0025	.0025	.0025	.0024	.0024	.0024	.0023	.0023	.0023	.0022	47
.0031	.0031	.0030	.0030	.0029	.0029	.0029	.0028	.0028	.0027	.0027	.0027	.0026	.0026	.0026	.0025	.0025	.0025	48
.0034	.0034	.0033	.0033	.0032	.0032	.0031	.0031	.0031	.0030	.0030	.0029	.0029	.0029	.0028	.0028	.0028	.0027	49
.0038	.0037	.0036	.0036	.0035	.0035	.0034	.0034	.0034	.0033	.0033	.0032	.0032	.0031	.0031	.0031	.0030	.0030	50
.0041	.0041	.0040	.0039	.0039	.0038	.0038	.0037	.0037	.0036	.0036	.0035	.0035	.0034	.0034	.0034	.0033	.0033	51
.0045	.0044	.0044	.0043	.0042	.0042	.0041	.0041	.0040	.0040	.0039	.0039	.0038	.0038	.0037	.0037	.0036	.0036	52
.0049	.0048	.0048	.0047	.0046	.0046	.0045	.0044	.0044	.0043	.0043	.0042	.0042	.0041	.0041	.0040	.0040	.0039	53
.0054	.0053	.0052	.0051	.0051	.0050	.0049	.0048	.0048	.0047	.0047	.0046	.0045	.0045	.0044	.0044	.0043	.0043	54
.0058	.0057	.0057	.0056	.0055	.0054	.0054	.0053	.0052	.0051	.0051	.0050	.0049	.0049	.0048	.0048	.0047	.0046	55
.0063	.0062	.0062	.0061	.0060	.0059	.0058	.0057	.0057	.0056	.0055	.0054	.0054	.0053	.0052	.0052	.0051	.0050	56
.0069	.0068	.0067	.0066	.0065	.0064	.0063	.0062	.0061	.0061	.0060	.0059	.0058	.0057	.0057	.0056	.0055	.0055	57
.0074	.0073	.0072	.0071	.0070	.0069	.0068	.0067	.0066	.0066	.0065	.0064	.0063	.0062	.0062	.0061	.0060	.0059	58
.0081	.0079	.0078	.0077	.0076	.0075	.0074	.0073	.0072	.0071	.0070	.0069	.0068	.0067	.0067	.0066	.0065	.0064	59
.0087	.0086	.0084	.0083	.0082	.0081	.0080	.0079	.0078	.0077	.0076	.0075	.0074	.0073	.0072	.0071	.0070	.0069	60
.0094	.0092	.0091	.0090	.0089	.0087	.0086	.0085	.0084	.0083	.0082	.0081	.0080	.0079	.0078	.0077	.0076	.0075	61
.0101	.0100	.0098	.0097	.0095	.0094	.0093	.0092	.0090	.0089	.0088	.0087	.0086	.0085	.0084	.0083	.0082	.0081	62
.0109	.0107	.0106	.0104	.0103	.0101	.0100	.0098	.0097	.0096	.0095	.0093	.0092	.0091	.0090	.0089	.0088	.0087	63
.0117	.0115	.0114	.0112	.0110	.0109	.0107	.0106	.0104	.0103	.0102	.0100	.0099	.0098	.0097	.0095	.0094	.0093	64
.0126	.0124	.0122	.0120	.0118	.0117	.0115	.0114	.0112	.0111	.0109	.0108	.0106	.0105	.0104	.0102	.0101	.0100	65
.0135	.0133	.0131	.0129	.0127	.0125	.0123	.0122	.0120	.0119	.0117	.0116	.0114	.0113	.0111	.0110	.0109	.0107	66
.0144	.0142	.0140	.0138	.0136	.0134	.0132	.0130	.0129	.0127	.0125	.0124	.0122	.0121	.0119	.0118	.0116	.0115	67
.0154	.0152	.0150	.0148	.0145	.0143	.0141	.0140	.0138	.0136	.0134	.0132	.0131	.0129	.0127	.0126	.0124	.0123	68
.0165	.0162	.0160	.0158	.0155	.0153	.0151	.0149	.0147	.0145	.0143	.0141	.0140	.0138	.0136	.0135	.0133	.0131	69
.0176	.0173	.0171	.0168	.0166	.0164	.0161	.0159	.0157	.0155	.0153	.0151	.0149	.0147	.0145	.0144	.0142	.0140	70
.0188	.0185	.0182	.0180	.0177	.0175	.0172	.0170	.0168	.0165	.0163	.0161	.0159	.0157	.0155	.0153	.0151	.0150	71
.0200	.0197	.0194	.0191	.0189	.0186	.0183	.0181	.0179	.0176	.0174	.0172	.0170	.0167	.0165	.0163	.0161	.0159	72
.0213	.0210	.0207	.0204	.0201	.0198	.0195	.0193	.0190	.0188	.0185	.0183	.0180	.0178	.0176	.0174	.0172	.0170	73
.0226	.0223	.0220	.0216	.0213	.0210	.0208	.0205	.0202	.0199	.0197	.0194	.0192	.0190	.0187	.0185	.0183	.0181	74
.0240	.0237	.0233	.0230	.0227	.0224	.0221	.0218	.0215	.0212	.0209	.0207	.0204	.0201	.0199	.0196	.0194	.0192	75
.0255	.0251	.0248	.0244	.0241	.0237	.0234	.0231	.0228	.0225	.0222	.0219	.0216	.0214	.0211	.0209	.0206	.0204	76
.0270	.0266	.0263	.0259	.0255	.0252	.0248	.0245	.0242	.0239	.0236	.0233	.0230	.0227	.0224	.0221	.0219	.0216	77
.0287	.0282	.0278	.0274	.0271	.0267	.0263	.0260	.0256	.0253	.0250	.0246	.0243	.0240	.0237	.0235	.0232	.0229	78
.0303	.0299	.0295	.0291	.0286	.0283	.0279	.0275	.0271	.0268	.0264	.0261	.0258	.0255	.0251	.0248	.0245	.0242	79
.0321	.0316	.0312	.0307	.0303	.0299	.0295	.0291	.0287	.0283	.0280	.0276	.0273	.0269	.0266	.0263	.0260	.0257	80
.0339	.0334	.0330	.0325	.0320	.0316	.0312	.0308	.0303	.0300	.0296	.0292	.0288	.0285	.0281	.0278	.0275	.0271	81
.0358	.0353	.0348	.0343	.0338	.0334	.0329	.0325	.0321	.0316	.0312	.0308	.0305	.0301	.0297	.0294	.0290	.0287	82
.0378	.0373	.0367	.0362	.0357	.0352	.0348	.0343	.0338	.0334	.0330	.0326	.0321	.0318	.0314	.0310	.0306	.0303	83
.0399	.0393	.0387	.0382	.0377	.0372	.0367	.0362	.0357	.0352	.0348	.0343	.0339	.0335	.0331	.0327	.0323	.0319	84
.0420	.0414	.0408	.0403	.0397	.0392	.0386	.0381	.0376	.0371	.0367	.0362	.0357	.0353	.0349	.0345	.0340	.0336	85
.0443	.0436	.0430	.0424	.0418	.0412	.0407	.0401	.0396	.0391	.0386	.0381	.0376	.0372	.0367	.0363	.0359	.0354	86
.0466	.0459	.0452	.0446	.0440	.0434	.0428	.0422	.0417	.0412	.0406	.0401	.0396	.0391	.0387	.0382	.0377	.0373	87
.0490	.0483	.0476	.0469	.0463	.0456	.0450	.0444	.0439	.0433	.0427	.0422	.0417	.0412	.0407	.0402	.0397	.0392	88
.0515	.0507	.0500	.0493	.0486	.0480	.0473	.0467	.0461	.0455	.0449	.0444	.0438	.0433	.0427	.0422	.0417	.0412	89
.0540	.0533	.0525	.0518	.0511	.0504	.0497	.0490	.0484	.0478	.0472	.0466	.0460	.0454	.0449	.0444	.0438	.0433	90
.0567	.0559	.0551	.0543	.0536	.0529	.0522	.0515	.0508	.0502	.0495	.0489	.0483	.0477	.0471	.0466	.0460	.0455	91
.0595	.0586	.0578	.0570	.0562	.0555	.0547	.0540	.0533	.0526	.0519	.0513	.0507	.0500	.0494	.0488	.0483	.0477	92
.0623	.0614	.0606	.0597	.0589	.0581	.0573	.0566	.0559	.0551	.0544	.0538	.0531	.0525	.0518	.0512	.0506	.0500	93
.0653	.0643	.0634	.0626	.0617	.0609	.0601	.0593	.0585	.0578	.0570	.0563	.0556	.0550	.0543	.0537	.0530	.0524	94
.0683	.0674	.0664	.0655	.0646	.0637	.0629	.0621	.0613	.0605	.0597	.0590	.0582	.0575	.0569	.0562	.0555	.0549	95
.0715	.0705	.0695	.0685	.0676	.0667	.0658	.0649	.0641	.0633	.0625	.0617	.0609	.0602	.0595	.0588	.0581	.0574	96

TABLE VI - PHOTOELECTRIC ABSORPTION COEFFICIENT $\tau_K \times 10^{23}$, COMPUTED FROM EQUATION (8) - Concluded

	E_o								
Z	9.20	9.30	9.40	9.50	9.60	9.70	9.80	9.90	10.0
14	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
17	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
18	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
19	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
20	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
21	.0001	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000
22	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
23	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
24	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
25	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
26	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
27	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
28	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
29	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
30	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
31	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003
32	.0004	.0004	.0004	.0004	.0004	.0003	.0003	.0003	.0003
33	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004
34	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0004
35	.0006	.0006	.0005	.0005	.0005	.0005	.0005	.0005	.0005
36	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006
37	.0007	.0007	.0007	.0007	.0007	.0007	.0007	.0007	.0007
38	.0008	.0008	.0008	.0008	.0008	.0008	.0008	.0008	.0008
39	.0009	.0009	.0009	.0009	.0009	.0009	.0009	.0009	.0009
40	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010
41	.0012	.0012	.0011	.0011	.0011	.0011	.0011	.0011	.0011
42	.0013	.0013	.0013	.0013	.0013	.0012	.0012	.0012	.0012
43	.0015	.0015	.0014	.0014	.0014	.0014	.0014	.0014	.0013
44	.0016	.0016	.0016	.0016	.0016	.0015	.0015	.0015	.0015
45	.0018	.0018	.0018	.0017	.0017	.0017	.0017	.0017	.0017
46	.0020	.0020	.0020	.0019	.0019	.0019	.0019	.0019	.0018
47	.0022	.0022	.0022	.0021	.0021	.0021	.0021	.0020	.0020
48	.0024	.0024	.0024	.0024	.0023	.0023	.0023	.0023	.0022
49	.0027	.0027	.0026	.0026	.0026	.0025	.0025	.0025	.0025
50	.0030	.0029	.0029	.0029	.0028	.0028	.0028	.0027	.0027
51	.0032	.0032	.0032	.0031	.0031	.0031	.0030	.0030	.0030
52	.0035	.0035	.0035	.0034	.0034	.0033	.0033	.0033	.0032
53	.0039	.0038	.0038	.0037	.0037	.0036	.0036	.0036	.0035
54	.0042	.0042	.0041	.0041	.0040	.0040	.0039	.0039	.0038
55	.0046	.0045	.0045	.0044	.0044	.0043	.0043	.0042	.0042
56	.0050	.0049	.0049	.0048	.0048	.0047	.0047	.0046	.0046
57	.0054	.0053	.0053	.0052	.0052	.0051	.0050	.0050	.0049
58	.0059	.0058	.0057	.0057	.0056	.0055	.0055	.0054	.0053
59	.0063	.0063	.0062	.0061	.0060	.0060	.0059	.0059	.0058
60	.0068	.0068	.0067	.0066	.0065	.0065	.0064	.0063	.0063
61	.0074	.0073	.0072	.0071	.0071	.0070	.0069	.0068	.0067
62	.0080	.0079	.0078	.0077	.0076	.0075	.0074	.0073	.0073
63	.0086	.0085	.0084	.0083	.0082	.0081	.0080	.0079	.0078
64	.0092	.0091	.0090	.0089	.0088	.0087	.0086	.0085	.0084
65	.0099	.0098	.0097	.0095	.0094	.0093	.0092	.0091	.0090
66	.0106	.0105	.0104	.0102	.0101	.0100	.0099	.0098	.0097
67	.0114	.0112	.0111	.0110	.0108	.0107	.0106	.0105	.0104
68	.0121	.0120	.0119	.0117	.0116	.0115	.0113	.0112	.0111
69	.0130	.0128	.0127	.0125	.0124	.0123	.0121	.0120	.0119
70	.0139	.0137	.0135	.0134	.0132	.0131	.0129	.0128	.0127
71	.0148	.0146	.0144	.0143	.0141	.0140	.0138	.0137	.0135
72	.0158	.0156	.0154	.0152	.0150	.0149	.0147	.0146	.0144
73	.0168	.0166	.0164	.0162	.0160	.0158	.0157	.0155	.0153
74	.0178	.0176	.0174	.0172	.0170	.0169	.0167	.0165	.0163
75	.0190	.0187	.0185	.0183	.0181	.0179	.0177	.0175	.0173
76	.0201	.0199	.0197	.0194	.0192	.0190	.0188	.0186	.0184
77	.0214	.0211	.0209	.0206	.0204	.0202	.0199	.0197	.0195
78	.0226	.0224	.0221	.0219	.0216	.0214	.0211	.0209	.0207
79	.0240	.0237	.0234	.0232	.0229	.0226	.0224	.0222	.0219
80	.0254	.0251	.0248	.0245	.0242	.0240	.0237	.0234	.0232
81	.0268	.0265	.0262	.0259	.0256	.0253	.0251	.0248	.0245
82	.0283	.0280	.0277	.0274	.0271	.0268	.0265	.0262	.0259
83	.0299	.0296	.0292	.0289	.0286	.0283	.0280	.0277	.0274
84	.0315	.0312	.0308	.0305	.0301	.0298	.0295	.0292	.0289
85	.0333	.0329	.0325	.0321	.0318	.0314	.0311	.0308	.0304
86	.0350	.0346	.0342	.0339	.0335	.0331	.0327	.0324	.0321
87	.0369	.0364	.0360	.0356	.0352	.0349	.0345	.0341	.0337
88	.0388	.0383	.0379	.0375	.0371	.0367	.0363	.0359	.0355
89	.0408	.0403	.0398	.0394	.0390	.0386	.0382	.0377	.0373
90	.0428	.0423	.0419	.0414	.0409	.0405	.0401	.0396	.0392
91	.0450	.0444	.0439	.0435	.0430	.0425	.0420	.0416	.0412
92	.0472	.0466	.0461	.0456	.0451	.0446	.0441	.0436	.0432
93	.0494	.0489	.0483	.0478	.0473	.0468	.0463	.0458	.0453
94	.0518	.0512	.0506	.0501	.0495	.0490	.0485	.0480	.0474
95	.0542	.0536	.0530	.0524	.0519	.0513	.0508	.0502	.0497
96	.0568	.0561	.0555	.0549	.0543	.0537	.0531	.0526	.0520

TABLE VII - AUXILIARY TABLE FOR PHOTOELECTRIC ABSORPTION COEFFICIENT τ IN TABLE VI

$$\left[fN_a = \left(1.13 + \frac{Z-1}{81}0.07\right)\frac{N\rho}{A}\right]$$

Z	fN_a	Z	fN_a	Z	fN_a
3	0.5246×10^{23}	26	0.9764×10^{23}	[1,i]50	0.3449×10^{23}
4	1.399	27	1.048	[1]51	.3881
[1,a]5	1.577	28	1.053	52	.3457
[1,b]5	1.545	[1]29	.9763	53	.2748
[1,a]6	1.137	30	.7596	[1]55	.0997
[1,c]6	1.279	[1]31	.5921	56	.1808
[1,d]6	1.996	[1]32	.5240	57	.3141
11	.2893	33	.5335	72	.5342
12	.4912	34	.4243	[j]73	.6588
[1]13	.6879	37	.1253	[k]73	.5751
14	.5877	[1]38	.2076	74	.7540
[e]15	.4040	39	.4340	75	.7925
[f]15	.4884	40	.4919	76	.8506
[g]16	.4445	[1]41	.6343	77	.8364
[h]16	.4202	42	.7459	[1]78	.7894
[1]19	.1518	[1]44	.8498	[1]79	.7056
20	.2669	[1]45	.8477	80	.4872
[1]21	.3816	[1]46	.7590	81	.4187
22	.6495	47	.6859	82	.3956
[1]23	.7580	48	.5422	[1]83	.3368
[1]24	.9184	[1]49	.4474	88	.1605
25	.9086	[1,e]50	.4273	[1]90	.2479
				92	.5720

[a]Amorphous
[b]Crystals
[c]Graphite
[d]Diamond
[e]White
[f]Red
[g]Rhombic
[h]Monoclinic
[i]Gray
[j]Metal
[k]Powder

[1]These values have been calculated using densities in reference 22 because the densities listed in different sections of reference 6 disagreed among themselves by as much as 25 percent.

TABLE VIII - PAIR-FORMATION COEFFICIENT $\chi(\alpha)$
COMPUTED FROM EQUATION (9)

E_o (Mev)	$\chi(\alpha)$ (sq cm/atom)	E_o (Mev)	$\chi(\alpha)$ (sq cm/atom)	E_o (Mev)	$\chi(\alpha)$ (sq cm/atom)
1.50	0.0477	6.10	2.37	11.4	4.06
1.60	.109	6.20	2.41	11.6	4.11
1.70	.149	6.30	2.45	11.8	4.16
1.80	.195	6.40	2.49	12.0	4.21
1.90	.244	6.50	2.53	12.2	4.25
2.00	.296	6.60	2.57	12.4	4.30
2.10	.351	6.70	2.61	12.6	4.34
2.20	.408	6.80	2.65	12.8	4.39
2.30	.465	6.90	2.69	13.0	4.43
2.40	.522	7.00	2.73	13.2	4.48
2.50	.579	7.10	2.76	13.4	4.52
2.60	.636	7.20	2.80	13.6	4.56
2.70	.692	7.30	2.83	13.8	4.61
2.80	.747	7.40	2.87	14.0	4.64
2.90	.801	7.50	2.91	14.2	4.69
3.00	.859	7.60	2.94	14.4	4.73
3.10	.916	7.70	2.98	14.6	4.77
3.20	.973	7.80	3.01	14.8	4.80
3.30	1.03	7.90	3.05	15.0	4.84
3.40	1.09	8.00	3.08	15.2	4.88
3.50	1.15	8.10	3.11	15.4	4.92
3.60	1.20	8.20	3.15	15.6	4.96
3.70	1.25	8.30	3.18	15.8	4.99
3.80	1.30	8.40	3.21	16.0	5.03
3.90	1.36	8.50	3.24	16.2	5.07
4.00	1.41	8.60	3.28	16.4	5.10
4.10	1.46	8.70	3.31	16.6	5.14
4.20	1.51	8.80	3.33	16.8	5.17
4.30	1.55	8.90	3.37	17.0	5.21
4.40	1.60	9.00	3.40	17.2	5.24
4.50	1.65	9.10	3.43	17.4	5.28
4.60	1.70	9.20	3.46	17.6	5.31
4.70	1.75	9.30	3.49	17.8	5.33
4.80	1.80	9.40	3.52	18.0	5.37
4.90	1.84	9.50	3.55	18.2	5.40
5.00	1.89	9.60	3.57	18.4	5.44
5.10	1.94	9.70	3.61	18.6	5.47
5.20	1.98	9.80	3.64	18.8	5.50
5.30	2.03	9.90	3.66	19.0	5.53
5.40	2.07	10.00	3.69	19.2	5.56
5.50	2.12	10.20	3.74	19.4	5.59
5.60	2.16	10.40	3.80	19.6	5.62
5.70	2.20	10.60	3.85	19.8	5.65
5.80	2.24	10.80	3.90	20.0	5.68
5.90	2.29	11.00	3.96		
6.00	2.33	11.20	4.01		

NACA

TABLE IX - AUXILIARY TABLE FOR χ IN TABLE VIII

Z	$\frac{r_o^2 Z^2 N_a}{137}$	Z	$\frac{r_o^2 Z^2 N_a}{137}$	Z	$\frac{r_o^2 Z^2 N_a}{137}$
3	2.418×10^{-4}	26	332.2×10^{-4}	[1,i]50	426.5×10^{-4}
4	11.46	27	384.4	[1]51	499.0
[1,a]5	20.16	28	415.1	52	461.7
[1,b]5	19.77	[1]29	412.5	53	381.0
[1,a]6	20.93	30	343.2	[1]55	148.6
[1,c]6	23.54	[1]31	285.4	56	279.0
[1,d]6	36.74	[1]32	268.9	57	502.2
11	17.82	33	290.9	72	1348
12	35.97	34	245.4	[j]73	1708
[1]13	59.12	37	85.67	[k]73	1491
14	58.54	[1]38	149.6	74	2007
[e]15	46.16	39	329.1	75	2164
[f]15	55.79	40	392.0	76	2384
[g]16	57.72	[1]41	530.7	77	2404
[h]16	54.56	42	654.8	[1]78	2326
[1]19	27.73	[1]44	817.3	[1]79	2133
20	54.01	[1]45	852.1	80	1509
[1]21	85.36	[1]46	800.3	81	1328
22	158.8	47	750.7	82	1285
[1]23	203.0	48	618.5	[1]83	1121
[1]24	267.6	[1]49	531.9	88	598.1
25	286.1	[1,e]50	528.4	[1]90	1341
				92	2321

[a]Amorphous
[b]Crystals
[c]Graphite
[d]Diamond
[e]White
[f]Red
[g]Rhombic
[h]Monoclinic
[i]Gray
[j]Metal
[k]Powder

[1]These values have been calculated using densities in reference 22 because the densities listed in different sections of reference 6 disagreed among themselves by as much as 25 percent.

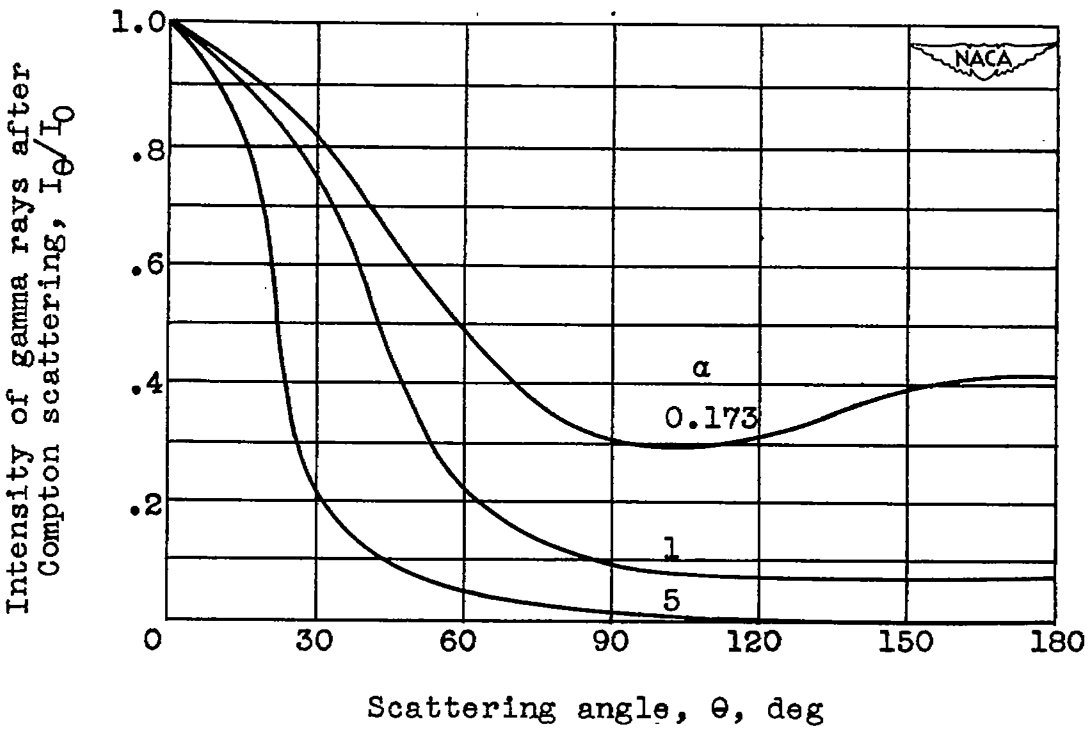

Figure 1. - Intensities of gamma rays at various scattering angles after Compton scattering I_θ/I_0 computed from equation (3). (Data obtained from reference 3.)

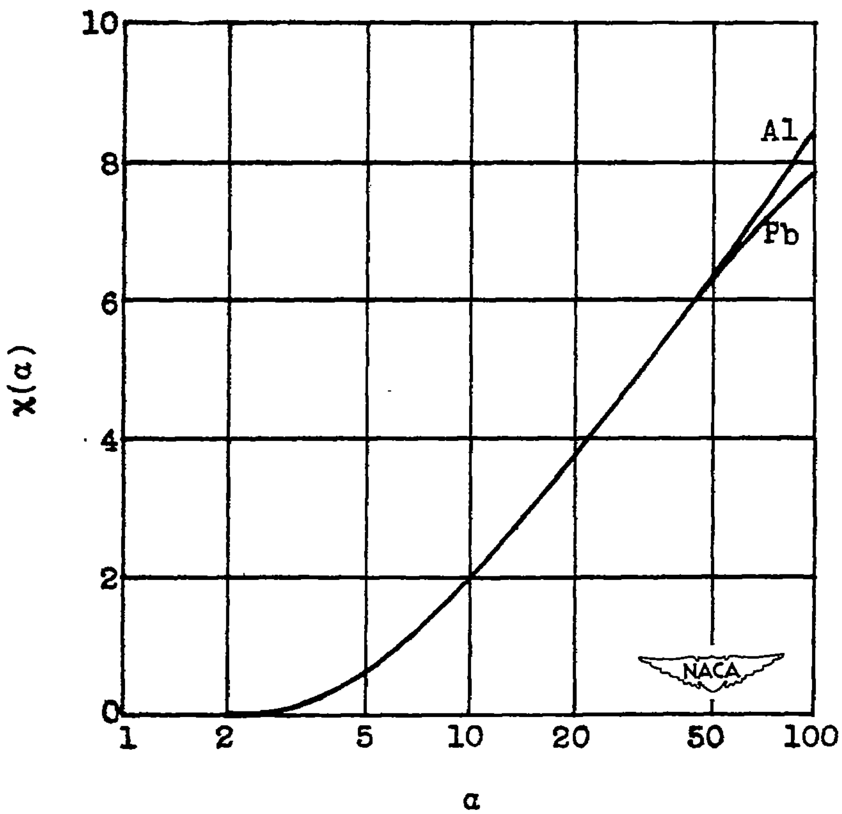

Figure 2. - Variation of $\chi(\alpha)$ computed from equation (9) with α. (Data obtained from reference 3.)